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PREFACE

Agricultural Finance Review provides a forum for presentation of research and discussion of issues in agricultural finance. Publication is annual, and all articles are contributed by scholars in the field. Articles on assigned topics may occasionally be commissioned from specific authors.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the United States Department of Agriculture. *AFR* was begun in 1938 by Norman J. Wall and Fred L. Garlock, whose professional careers shaped much of agricultural finance research for many years. Since that time, professional interest in agricultural finance has continued to grow, involving larger numbers of people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing effort.

The effectiveness of this publication as a means of promoting agricultural finance research and discussion depends on its support by the profession. We have been pleased by the response to date. Sixteen manuscripts were submitted for volume 44. The nine contained herein were selected for publication. We thank all those who submitted manuscripts.

We wish to express our sincere thanks to those who contributed their valuable time to review submissions for us:

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We invite your suggestions for making improvements in *Agricultural Finance Review.* Manuscripts for the 1985 issue should be received by February 1, 1985. Manuscripts will be accepted at any time, however, and those received after February 1 will be considered for the 1986 issue.

John R. Brake, Editor
Eddy L. LaDue, Associate Editor
Loren Tauer, Associate Editor

Current Financial Stress Among Farmers in South Georgia

Wesley N. Musser, Fred C. White, and G. Scott Smith

Abstract

A severe cost-price squeeze, high interest rates, and the stagnation of land prices have created a financial crisis for many farmers in the United States. This paper considers the current ramifications of this crisis for Georgia farmers. A survey of farmers in South Georgia generated data that reveal an array of current financial situations, that range from normal levels of leverage to a large number of insolvent firms. A simulation analysis of a representative farm for the period of 1974-1981 is used to relate expansion strategies to this current situation. None of the different strategies analyzed resulted in financial situations outside the bounds of the survey.

The current financial stress among farm firms is reported and discussed continually in the popular press and is receiving attention from agricultural economists. In a recent article on financial conditions among southeastern farmers, Sullivan and Wilson predicted that as many as 3,000 farm firms in this area will not survive. The recent economic conditions that created this stress are well known: lower output prices for most field crops, continued increases in the cost of production due to inflation, stagnation or declines in farm real estate values, and high interest rates. Although these conditions can create financial management problems for all firms, some firms experience more severe financial problems than others. Firm growth research has analyzed the impact of different economic situations and management strategies on financial conditions of farm firms. Most recent studies—unlike earlier research in this area—have at least identified situations and strategies with some probability of failure (Musser and White; Patrick; Mapp, et al.; Richardson and Condra; Held and Helmers). All of these studies were concerned with projecting future consequences of current actions. An interesting issue is the capacity of this well-established methodology to model the recent financial conditions of farmers, particularly as influenced by expansion.

The objective of this paper is to assess the current financial condition of farmers in South Georgia. The specific purpose is to present some data on the current financial situation of farm firms and to analyze the impact of expansion on current financial conditions for a representative farm firm. Information from a survey of farmers is the source of data on the current financial situation. A simulation model is utilized to analyze the impact of expansion strategies on the current financial condition.

Wesley N. Musser is an associate professor, Fred C. White is a professor, and G. Scott Smith is a graduate research assistant in the Department of Agricultural Economics, University of Georgia. The authors thank John R. Brake, Bernard V. Tew, Loren Tauer, and two anonymous reviewers for their helpful comments on an earlier draft of this paper.

Current Financial Situation of Farmers in South Georgia

The data on current financial conditions reported in this paper came from a survey of peanut farmers. The main purpose of the survey was to obtain information on pest management practices for peanuts; questions on the financial situation of the farm firm were included along with questions about other management practices. The data were collected in a telephone survey in late spring and early summer of 1982. The survey was administered to a random sample of peanut producers in six Georgia counties. The sample was stratified by county and pest management practices. The list of peanut producers was provided by the Georgia State Office of Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture (USDA). A total of 240 producers were telephoned with 192 or 80 percent completing most of the survey. Data on financial situations were obtained from 170 farmers.

One question about the financial situation concerned the farmers' current debt-to-asset ratio. This approach was based on the judgment that farmers would be more likely to disclose a ratio than information about absolute levels of debts and assets. The particular question had a series of steps. First, producers were asked to estimate the value of their total assets (they were informed that assets include everything owned, including land, machinery, livestock, cash, stocks and bonds). Then they were asked to estimate their total debts. The producers were not asked to report either of these values to the interviewer. The producers were then given a number of mutually exclusive alternative relationships between the data, such as debts being equal to assets or debts being more than twice as much as assets, and asked to identify the category closest to their own situation. The categories were created to reflect most plausible leverage relationships which could easily be communicated in the survey. These categories corresponded to debt-to-asset ratios of 200 percent, 101 to 199 percent, 100 percent, 50 percent, 33 percent, 25 percent, and 20 percent.

Survey results are summarized in three financial categories in table 1. All those whose responses indicated a debt-to-asset ratio greater than 100 percent could be considered effectively insolvent. The second group, with debt-to-asset ratios between 51 and 100 percent, could be considered experiencing financial stress. The third group with debt-to-asset ratios of 50 percent or less reflect normal financial conditions. Of the respondents completing the survey, 28.8 percent were insolvent, 40 percent were experiencing financial stress and 31.2 percent were in normal conditions. Tenancy and the respective debt-to-asset conditions are also shown in table 1. Operators who own all the land they farm tended to be in normal financial situations (55.6 percent) while operators who rent all of their land tended to be experiencing stress or insolvency (86.7 percent). Peanut allotment leasing situations showed that operators leasing-out peanut allotments were generally

Table 1. Survey Results of Farmers' Financial Conditions, 1982[a]

Debt-to-Asset Ratio	Financial Condition	Respondents						
		Land			Peanut Allotments			
		Owners	Rent-Own	Renters	Owner (Not Rent)	Rent-Out	Rent-In	Total
0-50%	Normal	35 (55.6)[b]	16 (17.4)	2 (13.3)	21 (52.5)	5 (62.5)	27 (22.13)	53 (31.2)
51-99%	Financial Stress	19 (30.2)	43 (46.7)	6 (40.0)	15 (37.5)	1 (12.5)	52 (42.62)	68 (40.0)
100% or greater	Insolvent	9 (14.3)	33 (35.9)	7 (46.7)	4 (10.0)	2 (25.0)	43 (35.25)	49 (28.8)
Total		63 (100.0)	92 (100.0)	15 (100.0)	40 (100.0)	8 (100.0)	122 (100.0)	170[c] (100.0)

[a]A stratified random sample of farmers with peanut production in six counties of South Georgia.

[b]Percent of debt-to-asset ratio by type of respondent.

[c]Twenty-two of the 192 respondents chose not to respond to the debt-to-asset question.

under normal financial conditions (62.5 percent) while operators leasing-in allotments were under stress or insolvent (77.87 percent).

These data indicate that current financial conditions are quite severe for this group of Georgia farmers. Farm firm bankruptcies occur under all economic conditions for various reasons (Shepard and Collins). However, usual distributions of financial conditions do not include so high an incidence of financial stress and insolvency. For example, Lins, Gabriel, and Sonka reported that 66 farm operations out of a national sample of 3,637 had a debt-to-asset ratio of greater than 50 percent at the end of 1975. One would expect the current situations to be worse than in 1975, but these data indicate a severe financial situation for a large proportion of farms.

Several reasons could be suggested for an upward bias in the reported debt-to-asset ratios. In regard to the particular question, farmers are more likely to be able to rapidly estimate total debts than total assets—the current value of some assets may be unknown and some assets may be overlooked during rapid mental calculations. Furthermore, the timing of the survey—early summer—would have yielded higher debt-to-asset ratios than other times of the year because that is when debt for operating inputs for crops is probably at its highest level while the value of growing crops would not have been realized or included in the total assets. On the other hand, peanut producers would have been expected to be in sounder financial condition than most Georgia farmers. However, a severe drought in Georgia in 1980 resulted in a state average yield of 1,935 pounds per acre—considerably below the average production of 3,256 pounds per acre for the previous two years (Georgia Crop Reporting Service). This low yield created unusually severe financial stress for peanut producers because of high input levels on this enterprise so that the normal advantage of peanut production may not have existed.

While some upward bias may be present in the responses shown in table 1, aggregate data also suggest severe financial stress among Georgia farmers. In January 1981, the Economic Research Service of the USDA reported an aggregate debt-to-asset ratio of 26.5 percent for Georgia farmers—the highest state ratio (1982a, p. 5). On January 1, 1982, the Farm Credit Administration reported that 50 percent of the institutional nonreal estate debt in Georgia was held by the Farmers Home Administration; this debt of over $995 million was second in absolute amount only to Texas (pp. 16-17).

While the percentages in table 1 must be interpreted with some caution, it is obvious that a large number of the sample farmers were in severe financial condition. However, the large group that is in normal economic conditions is also quite noteworthy. Some set of management strategies allowed this group of producers to maintain a sound financial condition despite the generally unfavorable conditions. The tabulations in table 1 suggest that owning, rather than leasing, land and peanut allotments may be two of the preferred strategies. The simulation analysis that follows looks at the impact of some expansion strategies on these current financial conditions. Expansion under different land tenure situations will be stressed because of the survey results.

The Representative Farm Firm Simulation Model

The simulation model used in this study was adapted from a model used in earlier research (Musser and White; Musser, White, and Chang). Since the details of this model have been reported in publications on this research, the model will only be summarized in this section with attention to the parameters used in this analysis. The simulation process included financial accounting operations that estimated costs of input services and value of production, calculated income and social security taxes and debt service, and presented an annual financial summary. The simulator allowed annual adjustment of input prices, output prices, consumption expenditures, and asset values. Annual enterprise gross revenues are generated by a normal random number generator subject to a variance-covariance matrix of returns. Mean and variance of important financial variables from 20 repetitions were reported for each year in the simulation period. These variables include net income, assets, liabilities, and equity. The annual changes in these variables and the final year financial condition can then be observed and analyzed for a given beginning position.

The simulation analysis was based on a farm situation that was representative of South Georgia. Principal enterprises were tobacco, peanuts, cotton, corn, soybeans, and hogs. Initial assets included 200 acres of farmland, machinery, equipment, and working capital. For this paper, the simulation period was the seven years 1974-1981. Mean prices and yields were initially 1974 levels; prices were adjusted for observed trends over the period (table 2). Random gross incomes for all enterprises were generated to be consistent with the means and observed variance and covariance relationships over the period.

Two basic financial situations were considered in the analysis. Initial assets were assumed to be $164,288 in all situations and beginning debts were assumed to be either 30 percent or 50 percent of assets. Beginning level for nonreal estate debt was $16,470 and real estate debt was $32,816 for the 30 percent debt situation. Interest rates were 11.8 percent and 15.2 percent for real estate and nonreal debt, respectively, and were assumed constant for the simulation period. While trends in interest rates would have been more appropriate, the simulator did not have this capacity. The rates utilized were representative of the whole period. Asset values were adjusted annually to reflect observed trends (table 2). Consumption withdrawals were assumed initially to equal $15,000 with appropriate adjustments for trends during the period (table 2).

Table 2. Annual Price Trends Associated With Historical Inflation, 1974-1982

	Annual Rate of Increase
Peanuts[a]	.0440
Tobacco[a]	.0586
Cotton Lint[a]	.0000
Cotton Seed[a]	.0000
Corn[a]	.0000
Soybeans[a]	.0000
Wheat[a]	.0000
Hogs[a]	.0000
Coastal Bermuda Hay[a]	.0787
Annual Production Expenditures[b]	.0702
Farm Machinery[b]	.1444
Livestock Equipment[b]	.0813
Land Price[c]	.1185
Land Cash Rent[c]	.0596
Consumption Expenditures[b]	.1082

[a]Calculated from detrended prices (U.S. Department of Agriculture, Statistical Reporting Service).

[b]Calculated from index numbers (U.S. Department of Agriculture, Statistical Reporting Service).

[c]Calculated from first and last year prices (U.S. Department of Agriculture, Economic Research Service, 1982b).

With this simulator, several alternative growth strategies were analyzed: (a) continuation of the base farm situation, (b) expansion by purchasing 200 acres in 1974, (c) expansion by renting 200 acres as of 1974, and (d) expansion by purchasing 200 acres in 1974 and 200 additional acres in 1978. The expansion process also took into account incremental nonland resources for the expanded farm. The rental strategy included cash rent for the land and associated peanut and tobacco allotments, which were inflated at the historical rate for cash rents (table 2).

In general, this research utilizes standard simulation methodology for an *ex post* analysis of this historical period. As with past applications of such simulators random outcomes are generated given basic parameters observed during the period, and means and variances of financial results of the random outcomes are calculated. For the purpose of this paper, an alternative would have been to utilize historical values of all the parameters. However, utilization of probabilistic methodology allows an evaluation of the standard methodology. This research provides some evidence on whether current financial situations could have been projected with this methodology, if the correct forecasts of basic parameters had been employed. This issue will be further discussed in the conclusions.

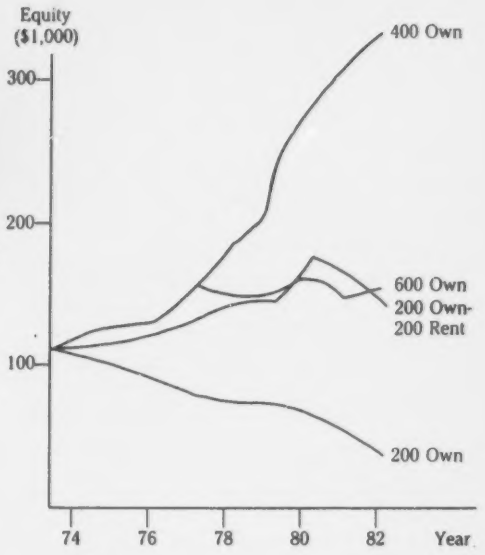
Farm Simulation Results

Final year financial conditions from seven years of simulation for the alternative growth strategies are summarized in table 3. Continuation of the initial farm size of 200 acres resulted in a substantial erosion of equity through time. The final equity level for this case was only one-half of the initial equity level assuming a beginning debt-to-asset ratio of 30 percent. However, the probability that this firm would be insolvent, or have a debt-to-asset ratio greater than or equal to 100 percent, was only 0.017. If this farm had started out with a heavier debt load, the probability of insolvency would have been much greater. Assuming an initial debt-to-asset ratio of 50 percent, the probability that this

farm would fail without growth is 0.450. This size farm was apparently not an economical size unit to support a family during this period.

Continuation of operation of the farm at 200 acres is compared with expanding the farm (a) by purchasing 200 acres in 1974, (b) renting 200 acres beginning in 1974, and (c) purchasing 200 acres in 1974 and an additional 200 acres in 1978. Purchasing 200 acres in 1974 was the most desirable alternative. Such expansion was desirable because it allowed achievement of significant economies of size and also because the farm experienced favorable land value appreciation on the purchased land throughout that period. The probability that this farm would be insolvent was zero, even with an initial 50 percent debt-to-asset ratio. Expansion by renting was less desirable because the farm experienced rising costs of production without favorable land value appreciation on purchased land; the slower rate of increase in cash rents than other production expenditures was helpful for this scenario. The probability of the rented farm being insolvent was only .005 under the 50 percent initial debt situation. The farm situation that operated at 400 acres for five years and then at 600 acres for the rest of the period fared better than the no-expansion situation, but outcomes were mixed in comparison to the rental situation. While the larger farm had higher mean equity and no probability of insolvency, it did have a slightly higher probability of the debt-to-asset ratio being greater than 80 percent than did the rental strategy.

Figure 1. Equity Accumulations for Alternative Growth Strategies



The farm situation with 50 percent initial debt, which was analyzed under four alternative expansion strategies, is depected in figure 1. The first strategy—continuation of a 200-acre operation—was the least desirable throughout the entire period. Equity under this strategy showed a steady decline. The three expansion strategies had different results. The 200-acre rental strategy showed growth through 1980 and then rapid decline. The strategy with two

Table 3. Final Year Income and Equity Conditions for Different Firm Sizes

Firm Size (Acres)	Net Income After Taxes ($) Mean	Net Income After Taxes ($) Standard Deviation	Equity ($) Mean	Equity ($) Standard Deviation	Debt-to-Asset Ratio	Probability of Debt-to-Asset Ratio ≥100%	Probability of Debt-to-Asset Ratio ≥80%
30% Initial Debt							
200 own	−8,093	6,458	57,459	21,667	.831	.017	.318
400 own	35,166	13,954	384,663	43,199	.350	.000	.000
200 own 200 rent	−5,796	13,687	188,998	50,480	.598	.000	.039
600 own	10,489	16,101	192,157	42,041	.689	.000	.063
50% Initial Debt							
200 own	−12,058	6,414	12,810	21,337	.963	.450	.991
400 own	31,160	13,951	339,198	45,935	.415	.000	.000
200 own 200 rent	−10,080	13,739	140,711	48,607	.461	.005	.044
600 own	5,531	16,033	148,222	49,373	.760	.000	.290

200-acre purchases exhibited stagnation after the second expansion. Finally the 200-acre purchase strategy showed steady growth throughout the planning horizon.

It must be stressed that while the simulations reflected conditions over the 1974-1981 period, they generated net incomes randomly from means, variances, and covariances for the entire period. In contrast, the worst years during this period were concentrated in the last few years. Thus, the net income and equity figures in table 3 are probably somewhat optimistic. Nevertheless, the results demonstrate considerable financial stress for many situations. The results are consistent with the overall survey patterns with reference to land tenure. Full ownership strategies were superior to the ownership-rental strategy for the expanded farms. However, the ownership patterns also indicate a possibility of stress particularly for the 200-acre unit and the 600-acre unit.

Conclusions

The recent adverse economic conditions have created severe economic stress for Georgia farmers. Nearly 30 percent of the respondents in a telephone survey reported that they were insolvent. A standard simulation analysis of the historical period for a representative farm suggested several expansion situations which could have created this stress. Surprisingly, the most favorable strategy proved to be the purchase of additional land early in this period, resulting in steady growth in equity and no financial stress even for the higher leveraged situation. In contrast, no expansion was the worst strategy, resulting in a steady decline in equity and a high probability of failure. A two-stage growth strategy to 600 acres resulted in stagnation after the second expansion. Expansion by rental of increased acreage was superior to no expansion but inferior to land purchases.

These results suggest some broader implications. Larger initial owned acreage and/or a lower initial leverage position would probably have resulted in a better current financial situation than the situations simulated. In contrast, a higher initial leverage situation, later land purchases, and/or no initial land ownership would likely result in a worse current equity position. These results correspond with earlier studies that examined low resource and rental situations (Patrick; Richardson and Condra). Farm firms with these financial strategies are likely to be those concentrated in the high stress and insolvent situations. As earlier firm growth literature has stressed, purchase of additional land is desirable especially if it is purchased early in the planning horizon. Later purchases did cause an erosion of equity.

From a management perspective, purchase of land with an unfavorable operating cash flow perspective, as shown in the trends in table 2, is not to be recommended. However, land purchases with immediate profitable operating conditions are desirable because the land value appreciation provides a financial cushion and, as in this study, allows equity to continue growing even in an unfavorable cost-price situation. The other management implication of this analysis concerns expansion to achieve economies of size. The desirability of the expansion strategies over the current situation, as demonstrated in this paper, can be attributed largely to the increase in efficiency in machinery use on the 400-acre farm. Only minimal incremental increases in machinery were necessary for this expansion, so that the greater operating net cash flows did not require much increase in fixed costs of machinery. Part of the problem with two-stage expansion strategy was that few economies of size exist for expansion from 400 acres to 600 acres—additional machinery investment for expansion to 400 acres was $20,310 and for expansion on to 600 acres was an additional $60,015. Thus, these results are consistent with the reasoning of Shepard and Collins concerning economies of size and stress from expansion.

A final methodological implication is that current firm simulation methodology can model situations which produce severe financial stress for a large segment of farms but not for all farm firms. While the survey did provide some data to validate the results, questions on expansion were not included so the simulation analysis could not be completely validated. Such questions would gather information on actual past expansion, planned expansion, and an individual's criteria for evaluating expansion alternatives. As Hanson and Eidman have stressed recently, such validation is necessary before confidence can be placed in the simulation. A broader survey than reported in this paper plus an *ex*

post simulation similar to the one in this paper is one approach to validate simulation models. However, such an approach will still not validate forecasts of the probability distributions of future outcomes. Since this paper was concerned with simulation of a historical period, no evidence was provided on this crucial input for a simulation model to be used to forecast the future financial consequences of different managerial strategies.

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Credit Scoring for Farm Loan Pricing

Jean Lufburrow, Peter J. Barry, and Bruce L. Dixon

Abstract

A credit scoring technique for pricing loans to individual farm borrowers is evaluated using financial data from five production credit associations (PCA) in Illinois that currently price loans based on credit risk. Statistical analysis using a probit model to account for the qualitative and ranking characteristics of the problem yielded five significant variables — leverage, liquidity, repayment history, collateral, and cash flow. In various tests, the model classified 70 to 80 percent of the PCA borrowers correctly. In general, the results indicate that credit scoring may play a useful role as a tool in loan pricing.

Key words: credit scoring, loan pricing, risk analysis.

The assessment of lending risks for purposes of pricing, supervision, and control has become a timely issue for the Farm Credit System, agricultural banks, and other farm lenders (Bullock; Etherton; Barry and Calvert). The high risks in agriculture, including greater losses for some lenders, growing competition in farm lending, and improvements in the quality and computational processing of financial information are all encouraging agricultural lenders to more precisely evaluate and monitor the credit worthiness of their borrowers. As a result, improved methods of loan pricing should enhance the performance of loan portfolios, lessen the reliance on nonprice factors in credit allocations, and contribute to more efficient, equitable credit services for borrowers.

In this article we estimate and test a credit scoring model that could be used for pricing loans to individual farm borrowers. The analysis utilizes financial data from five production credit associations in Illinois that currently price loans based on differences in borrowers' credit risks. In the following sections we review related literature and develop and test the credit scoring model. Variables believed to influence credit risks are evaluated statistically using a probit model with an ordinally ranked dependent variable that accounts for the qualitative and ranking characteristics of the problem. The validity of the results is considered, along with the general use of credit scoring in loan pricing.

Previous Studies

The use of statistical analysis to determine the relationship between financial variables and credit quality has had much attention in commercial and consumer lending (e.g., Shashua and Goldschmidt; Awh and Waters;

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Orgler). Bankruptcy forecasting is another major area of application (Altman; Collins; Meyer and Pifer). The statistical techniques used in these types of studies have included multiple discriminant analysis, the linear probability model, and logistic regression. Collins and Green evaluated the effectiveness of these methods and concluded that the logit approach has the most appropriate characteristics, although the forecasting accuracy of each method is uniformly good.

Some credit scoring studies have occurred in farm lending as well. Dunn and Frey, Hardy and Weed, Bauer and Jordan, and Johnson and Hagan all used discriminant analysis to classify loans into two categories, usually acceptable and problem loans. An extension of the Johnson and Hagan model has been used in credit examinations of PCAs by the St. Louis Federal Intermediate Credit Bank. While other credit scoring models are likely being used in agricultural lending the extent of such use is not documented, especially in loan pricing. In general, credit evaluations have mostly occurred through the personal observations and subjective judgments of loan officers, using what data farmers have supplied.

Model Development

The basic steps in credit scoring include identifying the variables that best distinguish among credit classes, assigning a proper weight to each variable, scoring each loan as the sum of the variables multiplied by their weights, and assigning the score to the appropriate class based on interclass threshold values. Ranges around the threshold values can be used to identify borderline cases requiring further appraisal by lenders. In principle, the credit score reflects the contribution of each risk factor to a lender's possible loan risk. Thus, the variables affecting credit worthiness provide a logical basis for model specification.

The major variables affecting credit risk, defined as possible loan performance problems, generally include a borrower's liquidity, leverage, profitability, collateral, tenure, repayment capacity, risk strategies, general management ability, along with repayment history and other personal characteristics. Liquidity reflects the firm's present capacity to generate cash to meet its financial obligations. Higher liquidity should signify lower credit risk. Leverage indicates the amount of debt relative to equity capital used by the borrower, with higher leverage adding to a firm's total risk. Profitability indicates the borrower's overall financial progress; it should be inversely related to credit risks, although lenders do not share directly in the borrower's profit position.

Collateral represents the pledge of assets to secure a loan in case of default; generally, more collateral relative to loan size is required on higher risk loans. Tenure reflects the mix of owned and leased assets; greater leasing generally increases risk due to uncertainties of continued asset use and a weaker collateral position. Repayment ability is the borrower's prospects for successfully meeting principal and interest obligations from future cash flows. The remaining variables account for the borrower's personal attributes, general proficiency as a farm operator, and special practices in risk management.

These variables differ in their ease and accuracy of measurement, and in their importance to different types of lenders. Several can be measured in alternative ways. Moreover, personal and management characteristics, while important in credit relationships, are especially difficult to separate from other variables and to measure accurately.

In the analysis below, the variables affecting credit worthiness are represented as follows:

Liquidity (CRL)—current assets divided by current liabilities, where liabilities include the new loan. Alternative liquidity measures are the current ratio and working capital divided by the amount of the new loan.

Leverage (LEV)—the debt to equity ratio.

Profitability (GEO)—the geometric mean of the rate of change in earned net worth in the previous two years. Alternative profitability measures are the ratio of projected earnings before interest and taxes to total assets, and the ratio of earned net worth to total assets.

Collateral (COL)—the ratio of PCA collateral to total PCA line of credit.

Tenure (TEN)—the ratio of acres owned and farmed to total acres farmed.

Repayment ability (CF)—projected net cash flow plus projected grain inventory divided by total line of credit. Alternative repayment measures include various versions of PCA loan margin.

Repayment history (HIS)—the average of loan principal repaid divided by principal due over the past three years serving as a proxy for personal factors and other influences on repayment history.

Statistical Method

An index that expresses the credit worthiness of a population of borrowers could be conceptualized as a continuous function that assigns each borrower an index value indicating his credit worthiness. The interest rate and other loan terms could then be tailored to each borrower's index value. In practice, however, this extent of ranking is not feasible. Most lenders group their borrowers into a few discrete classes for credit evaluation, pricing, monitoring, and so on. Thus, the dependent variable which signifies a borrower's risk class is discrete and ordinally ranked so that Class I, for example, contains borrowers with less credit risk than Class II, which has less risk than Class III, and so on.

The probit model with an ordinally ranked limited dependent variable (OLDV) representing the risk classes is suited for the unique qualitative and ranking characteristics of this problem (McKelvey and Zavoina). Probit analysis is a probability model that predicts the probability with which the observation on the dependent variable associated with a given set of independent variables will fall into a given dependent variable category (Pindyck and Rubinfeld). It utilizes a cumulative normal density function to transform an index number related to the probability of an event occurring into a probability. Given the true underlying model or any estimate of it, observations (i.e., borrowers) can be placed into classes according to the highest probability of occurrence, or by comparing computed dependent variables (credit scores) to threshold values for the categories. Unlike discriminant analysis, the OLDV probit model utilizes the ordinal ranking of the observed dependent variable which implies that more information is being utilized in the estimation process.

The OLDV probit model takes the form:
(1) $y_i = a + b_1 X_{1i} + b_2 X_{2i} + \ldots + b_n X_{ni} + \epsilon_i$
where y_i is the unobserved value of the dependent variable and ϵ_i is a random error term having a standard normal distribution.[1] W_i is the observed class of the i^{th} observation. An observation is assigned to the various classes based on the following scheme:

W_i = Class I if $y_i > t_2$
W_i = Class II if $t_1 < y_i < t_2$
W_i = Class III if $y_i < t_1$

The threshold structure t_1, t_2 specifies the boundaries of the groups comprising the observable dependent variable. Given that (1) has an intercept term and that the threshold values t_1 and t_2 are usually assumed unknown in empirical work, it is necessary to normalize one of the t_i. This is done here by setting $t_1 = 0$. The b_i coefficients are to be estimated, and the x_{ji} are the credit risk variables. The model is estimated using maximum likelihood (ML) procedures to yield consistent, asymptotically efficient estimates with known asymptotic sampling distributions (McKelvey and Zavoina). In contrast with the interpretation of the b_i coefficients in the classical regression model, the coefficients for this probit model represent the change in the unobserved dependent variable y_i for a unit change in the independent variable. However, for any practical meaning this change must be converted into the change in probability of being in a given class. Furthermore, the change in probability is a function of the level of all the independent variables. Thus, a change in CRL might increase the probability of being in a given class by .1 or .01, depending on the values of the independent variables.

Empirical Application

The credit scoring model was developed using 1982 data for a sample of borrowers from five PCAs in Illinois that classify their borrowers into three risk categories for pricing purposes. Thus the population to which the model

[1]Since y_i is never observed, its scale cannot be estimated. Hence, a normalization must be employed, and it is convenient to assume (1) has been normalized by dividing both sides of (1) by the true standard deviation of the error term, implying that the resulting error term has a variance of one. See McKelvey and Zavoina for more discussion of this identification problem.

applies consists of active borrowers, and does not include nonborrowers or rejected loan applicants. Ideally, the credit score should reflect the relative performance of these borrowers over a number of years. However, limitations on data and research resources compelled us to use the lenders' classifications as the measure for the dependent variable. Three of the PCAs are located in the major grain producing areas of Illinois where corn and soybeans are the principal enterprises. The other two PCAs are located in more diversified areas with dairy, beef, and hog enterprises common. Each of the PCAs priced their loans as: Class I, Prime (lowest risk); Class II, Base (intermediate risk); and Class III, Premium (highest risk). While all five PCAs used the same pricing classification, it is likely that credit quality of loans in each class differed slightly among the PCAs due to differences in credit philosophy of each PCA's management.

Each PCA was asked to select randomly a specified number of credit files from each of the three risk classes, for a total of 60 files at each PCA. This resulted in 241 usable observations: 81 from Class I and 80 each from Classes II and III. The most common reasons for not using observations were the lack of two or three years of data for new borrowers, and the lack of some pro forma data for low risk borrowers. The data in the credit files were organized and compiled in a similar fashion among the five PCAs and thus among their borrowers. The general approach is for the borrower to provide the data which are accepted as valid by the PCAs in their credit analysis. Farm visits by lenders and occasional verification of collateral values are common in the validation process.[2,3]

To estimate and validate the model a testing procedure is used which divides the sample of 241 borrowers into a model-generating sample of 202 and a test sample of 39. The test sample was chosen randomly from the complete sample. The coefficients of the credit scoring model were estimated from the model-generating sample and tested for predictive accuracy using the test sample. Additional tests also occurred on the model-generating sample itself, as well as using coefficients estimated from the total sample.

Model Results

The model that was determined the best in classifying the borrowers by credit risk is

$$y = .45 + 1.22\,CRL - .77LEV - .82COL + .43CF + 1.03\,HIS$$
$$(1.16)\quad (5.52)\quad (-4.45)\quad (-7.24)\quad (2.11)\quad (2.13)$$

Five factors are statistically significant at the five percent level (t ratios are in parentheses) in determining credit risk: liquidity, leverage, collateral, repayment ability, and repayment history. Profitability and tenure were insignificant and thus omitted from the model. The signs of the coefficients are as anticipated. The positive signs of CRL, CF, and HIS indicate that an increase in any of their values would increase the credit score, and thus reduce total credit risk. Finally, the correlations between the various risk variables are relatively low.[4]

Two threshold values exist for the model. One threshold must be prespecified; the suggested

[2]PCAs are generally considered to use uniform methods of loan analysis, credit evaluation, and risk assessment; however, differences may still occur in the completeness of financial data, especially for the most credit-worthy borrowers, and in the relative weights lenders assign the various credit factors. While these differences are considered minor and are difficult to measure, they may still influence the credit scoring analysis.

[3]Observations (116) lacking data for only one or two risk sources were still included in the analyses to assure a sufficient sample size. The measures for liquidity, leverage, collateral, and tenure were complete for every credit file. For profitability, repayment ability, and repayment history, however, median values of these variables for the respective credit classes were assigned to the missing values (the numbers of missing values provided in this manner are: CF, 93; HIS, 52; and GEO, 26). Also, a few observations were exceedingly large relative to the entire range of values for the variable involved. Since these outliers could substantially affect the results, the values of ten observations (five each for liquidity and leverage) were changed to equal the next highest values in the sample. For example, the current ratio for one borrower was reduced from 99,225 to 15. Lenders would likely not respond much differently in their risk assessment of these two values.

[4]Two of the coefficients also appeared sensitive to the sample selection, which was surprising given the relatively large sample. When estimates were based on the 241 observations, rather than the 202 observations in the model-generation, the coefficients for CRL and LEV declined to .85, and −.49, respectively; these changes tended to be counterbalancing. The values of other coefficients changed much less. This might imply a need for additional risk factors (independent variables) not available from the PCA records.

practice is to set t_1 equal to zero (McKelvey and Zavoina). The other threshold, t_2 thus becomes an identified parameter. It appears in the likelihood function and is thus estimated by ML. It equals 1.84. Credit scores (y_i) less than zero indicate high risk, and scores above 1.84 indicate low risk. Credit scores between zero and 1.84 indicate intermediate risk.

The model's predictive accuracy was evaluated by comparing the model's classification of borrowers to the PCA's classification. Two classification methods were used, based on (a) probabilities of being in the respective classes, and (b) comparisons of credit scores and threshold values. For method (a), the OLDV model generates probabilities of the borrower falling in each credit class. The borrower is then classified according to the highest probability. For example, borrower 1 had a 4 percent chance of being in Class III, a 20 percent chance for Class II, and a 76 percent chance for Class I. Since his PCA placed him in Class I, the model is considered to classify him correctly. Using this method, 66 percent of the model generating sample were classified correctly; the greatest accuracy occurred for Class I (94 percent) and Class III, (91 percent) compared to Class II (13 percent).

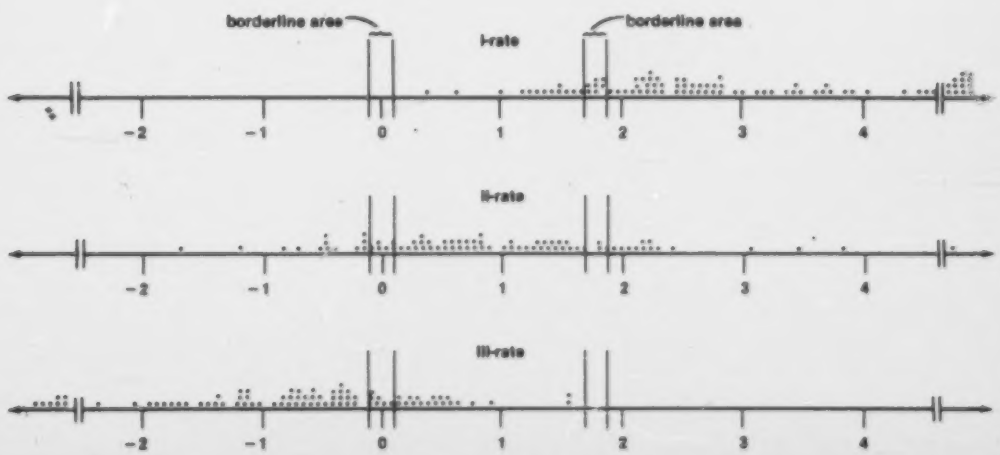
The second method of testing predictive accuracy is to classify borrowers based on comparisons of their credit scores to threshold values. A lender using the model would likely employ this method; thus, it is preferred here. This method correctly classified 79 percent of the test sample: 100 percent of Class I, 62 percent of Class II, and 77 percent of Class III. The lower accuracy for the middle group likely occurs because it is bounded on both sides by the outer groups. When applied to the entire sample of 241, the equation estimated from the 202 observations classified 71 percent of the borrowers correctly. This classification rate increased to 76 percent when borderline cases were considered as correctly classified.

As figure 1 shows, the majority of observations for each class are correctly classified. Some of these classifications fall near the threshold values and are borderline cases. Here, borderline cases are defined arbitrarily as those falling within $\pm .1$ of the threshold value. These observations could either be accepted as classified correctly (truly borderline), or they may be set aside for further evaluation by lenders to determine the appropriate classification.

Implications for Credit Analysis

These credit scoring results suggest that the scoring concept has promise as a tool to aid in risk classifications of borrowers for pricing purposes. Five of the risk variables were significant and had the correct signs using the

Figure 1. Computed Index Values for the Sample of PCA Borrowers



OLDV probit method, which properly accounts for the ranking and discrete characteristics of the risk classes. The rate of correct classifications (66 to 79 percent) is relatively high, especially since this analysis improved upon other credit classification studies by using three rather than two classes of acceptable borrowers. The rates of correct classification for other agricultural studies, based on the total sample and two classes, were as follows: Dunn and Frey, 75 percent; Johnson and Hagan, 62 percent; Hardy and Weed, 81 percent; and Bauer and Jordan, 85 percent.

Other factors also influenced the accuracy of the results. Two of the surveyed lenders observed that several of their own classifications should have been different; however, without these borrowers' requests for upgrading, the revision in classes tended to lag about a year. Second, some borrowers were borderline cases from the PCA's standpoint. Third, as indicated earlier the five PCAs likely differed in their credit policies and economic environment, although these differences were considered minor and were not tested. Fourth, credit evaluation is strongly influenced by subjective, nonquantifiable factors such as integrity, management ability, and spending habits, that are not easily modeled. Fifth, judging the model by its accuracy in reproducing lenders' decisions assumes that the lenders themselves were correct in predicting future loan performance even though errors likely occur. As indicated earlier, a better test of the model would analyze its accuracy in predicting borrowers' actual performance. This might involve comparing the credit score with farm firm performance in future years. For example, one might test to see if the model's risk classifications correspond with the firm's eventual change in net worth, realized cash available for debt servicing, or actual repayment performance.

The scoring method illustrated here is intended to aid in pricing loans. It provides a uniform and objective standard for pricing decisions based on differences in credit risks, while still allowing for further analysis of borderline borrowers. The estimation procedure can be tailored to the characteristics of specific lenders, locations, and types of borrowers. The lender can base the price spread for the respective classes on profitability targets for the total farm loan program, as well as considering the size of the classes, the incidence of loss within each class, competitive factors in the loan market, and experience with borrowers in their acceptance of differential rates. Lenders may also change the level and number of threshold values based on differences in their preferences for credit standards and desired precision in pricing; this would re-introduce some subjectivity into the process, although the measured risk and ranking of each borrower would remain the same. Alternatively, the model could be re-estimated based on different numbers of classes and thus threshold values.

The scoring approach also enables the lender to advise the borrower about the factors that comprise the credit score, and about trade-offs or changes needed in selected variables to warrant reclassification. For example, a borrower whose variables are valued CRL = .5, LEV = 3.00, COL = 2.0, CF = .8, and HIS = .8 would have a credit score of −1.72, placing him in Class III (high risk) for pricing purposes. To reach Class II, with a threshold value of zero, he might reduce leverage to 0.76, while holding other variables constant. Alternatively, he might increase liquidity to CRL = 1.00 and reduce leverage to LEV = 1.56, with other variables held constant. Other trade-offs could be similarly evaluated.

Clearly, credit scoring appears to have considerable usefulness as a tool in loan pricing decisions, as well as in identifying acceptable and unacceptable borrowers at loan application time. Additional study appears warranted to test the usefulness for different farm situations and for different types of lenders. As these studies accumulate, analysts, loan officers, and others will be better able to assess the importance of various risk factors, determine the usefulness of credit scoring models, and design more effective pricing policies.

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The Role of Federal Crop Insurance in Farm Risk Management

Warren F. Lee and Amadje Djogo

Abstract

This article examines the effects of the recently revised Federal Crop Insurance Corporation (FCIC) programs on income variability for a 600-acre, eastern cornbelt grain farm. Risk-returns trade-off frontiers were generated by MOTAD analysis. Results indicate that FCIC's area yield coverage does not reduce income variability; however, the Individual Yield Certification (IYC) option reduces income variability somewhat at the maximum coverage and price options. Farmers' use of FCIC coverage could be increased if higher coverage levels were offered in low-risk farming areas. All-peril crop insurance was also found to be effective in reducing loan losses for agricultural lenders.

Key Words: Federal Crop Insurance Corporation, farm income variability, MOTAD analysis, risk management.

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Risk and uncertainty are a fact of life in any business, and farming is generally perceived to be a risky business. The major sources of risk in farming include unstable product prices and yields, unpredictable variations in input costs, technological change, changing government policies, and personal risks affecting the operator and family. This study focuses on product yield risk.

Although the likelihood of severe crop losses due to natural hazards has been substantially reduced by technological advances, year-to-year variations in yields continue to pose a significant risk. Causes of yield risk vary greatly by commodity and by region. A summary of indemnities paid by the Federal Crop Insurance Corporation (FCIC) over the period 1948-1982 on all insured crops in the United States indicates that the four leading causes of reduced yield are: drought (41.9 percent of total indemnities); flood or excess moisture (17.7 percent); frost, freeze, or winter kill (14 percent); and hail (13.2 percent). The remaining 13.2 percent of total indemnities covered losses caused by wind, insects, disease, or other miscellaneous causes.

Moisture (too much or too little) is a major concern for all crop producers. It is widely recognized that the "dust bowl" drought of the 1930s was the most severe in United States history. It affected more than 75 percent of the nation's cropland and it severely affected 27 states. Severe yield losses combined with depressed commodity prices caused financial ruin for thousands of farmers. More recently, drought severely affected crop production in many parts of the nation in 1977, 1980, and 1983. Corn and soybean yields in the eastern cornbelt were reduced significantly in 1981 by excessive rainfall during the critical planting and early growing season.

Managerial Responses to Yield Risk

The primary response to yield variability caused by natural hazards has been widespread adoption of new technology. Chemical control of weeds and insects is now routinely used and modern genetics has produced varieties that are highly resistant to blights, rust, fungi, and so forth. For the most part, the costs of adopting chemicals and genetic improvements have been modest; however, there is continuing concern about potential adverse effects of chemicals on the environment. Moisture control—irrigation and drainage—are much more expensive and widespread adoption has been slow because of high initial investment and maintenance costs.

Despite technological advances, yield variability is still a major problem for most crop producers; thus, farmers typically adopt other management strategies to deal with yield and other risks. Most farmers, for example, carry several types of reserves. Excess machinery capacity reduces yield losses during unusually wet planting or harvesting seasons. Carry over feed inventories are commonly held by livestock producers as a hedge against short crops. Reserves of liquid assets and unused credit are widely used to minimize the financial consequences of low yields or other adversities. These reserves involve a significant opportunity cost.

Government Programs

Because yield and commodity price risk are so pervasive, the U.S. government has played a significant role in risk reduction since the 1930s. Commodity price support programs, special credit programs, and the all-risk crop insurance program were instituted in the 1930s in response to the widespread financial distress created by yield losses and depressed commodity prices during the Depression. The FCIC all-risk crop insurance program was first enacted in 1938 and originally covered only wheat. It has gradually been expanded and since 1983, FCIC all-risk insurance has been available on 30 different crops under 15,321 county programs.

In response to the long-standing problem of low participation, the FCIC program was substantially changed under the Federal Crop Insurance Program of 1980 (Todd). Ceilings on the number of counties and crops that can be added each year were removed. To facilitate this expansion the capital stock and annual operating expenses appropriations were increased. FCIC was also authorized to contract with private insurance companies and agents in writing coverage and marketing policies and to reinsure crop insurance offered by state and local governments.

The attractiveness of the insurance contract has also been enhanced (Griffin and Black; Willett). Three coverage levels—50, 65 and 75 percent of normal yield—and three price options are available. Producers who believe that their average production is understated by FCIC's area yield estimates can obtain higher coverages under the individual yield certification (IYC) or producer reported yield (PRY) options. To qualify for the IYC option, producers must document yields that have been above the area average for the last three or more years. The IYC option offers added coverage with no increase in premiums above the area average plan. PRY coverage is designed for livestock producers and requires one year of certified production and two years of reported production, approved by ASCS. Premiums for PRY coverage are proportionately higher than area yield premiums.

In addition to offering larger and more individualized policies, the FCIC was authorized to subsidize premiums on the 50 and 65 percent coverage levels. The authorized subsidy ranges from 20 to 40 percent. Producers buying 75 percent coverage receive the subsidy up to the 65 percent level, but must pay the full premium on the remaining 10 percent. Premium reductions are offered to producers with favorable continuous insurance experience, while those with unfavorable experience are subject to premium surcharges. FCIC premiums are calculated to cover only indemnities. Operating and administration costs are borne by taxpayers.

The decision to purchase FCIC all-risk crop insurance must be made prior to the planting season. Coverage is based on insurable units which are based on the farm accounting system. Some producers can qualify for more than one insurable unit, for example, one unit for owned land and additional separate units for rented land. Reports of loss are submitted after harvest. An FCIC adjustor visits the farm, measures any crop stored, inspects records of production sold or stored, and obtains

information regarding the size and condition of acreage planted. Indemnities paid are based on the adjustor's findings.

It is apparent from the recent modifications that FCIC's objective is to encourage above average producers to participate. The primary objective of this article is to report the effects of more individualized coverage plans on grain farmers who due to superior management and/or soil types do achieve above average yields. The actuarial feasibility of different coverage levels is examined using a unique but readily available source of crop yield data. Implications for producers, lenders and the FCIC are also examined.

Theory and Methodology

The analysis is based on the assumption that farmers make decisions on the basis of expected utility, where utility is a function of income and risk. In this study, income is defined as return above fixed costs, or gross margin, and risk is represented by the standard deviation of gross margin. In this study, the E-V efficient frontiers were developed using Hazel's MOTAD model. MOTAD generated frontiers represent sets of production plans that are efficient in the sense that total absolute deviations below the mean (A) are minimized for each level of expected income (E). In other words, MOTAD generates an E-A frontier which in most respects has properties similar to those of an E-V function originally developed by Markowitz. The major advantage of the MOTAD model is that it can be solved with conventional linear programming algorithms that have parametric options. E-V frontiers can be generated only by quadratic programming algorithms that are considerably more complex and more error prone (Tauer). Following Hazel's work, the MOTAD model has been used in a number of studies of decision making under risk in agriculture, for example, Schurle and Erven, Persuad and Mapp.

Data Requirements

The MOTAD model requires time series data on gross margins for each of the three crops analyzed: corn, wheat, and soybeans. Gross margin can be defined as

$$g = \sum_i P_i Y_i - \sum_j p_j x_j \qquad (1)$$

where P_i = the price received for crop i

Y_i = the yield per acre for crop i

p_j = price per unit of variable input j

x_j = quantity of variable input j used

Crop yield data (Y_i) were obtained from published results of variety test trials conducted by the Ohio Agricultural Research and Development Center (OARDC) in Wood County, Ohio, from 1972 to 1981. Annual yield observations for each of the three crops were computed as the simple average of four varieties. The varieties selected are widely used by commercial producers and were consistently tested throughout the ten-year period.

Ideally, yield data for a study of this type would be obtained from commercial producers. However, relatively few farmers keep accurate yield records over a ten-year period—the time period generally used by the FCIC to estimate its premium schedules. Hence, the cost of obtaining accurate, historical yield data from farmers was considered prohibitive. County average yields were another readily available source, but as Eisgruber and Schuman and others have pointed out, aggregate yield data series generally understate the variability experienced by individual farmers. Although the variety test yields may overstate estimated mean yields and understate yield variability, they are considered to be a reasonable proxy for the yield experience of the above average producers that FCIC hopes to attract with the new IYC and PRY options.

The Hoytville soil on which the tests were conducted is a dark-colored, poorly-drained clay that formed on high-lime glacial till on nearly-level lake plain topography. The site is tile-drained to correct the major hazard on this otherwise highly productive soil. Conventional tillage practices and recommended application rates of fertilizer, herbicides, and insecticides are followed and to the extent possible, the tests are designed to duplicate commercial production conditions.

Area and county cooperative extension agents confirmed that their "better" producers' average yields are similar to those reported from the variety tests. This assertion is to some extent verified by the yields used to compute the productivity indexes (PI) for Ohio soils. The PI yields represent levels that have been

achieved by 50 percent of the producers and are based on a combination of research data, soil interpretation record (SCS form No. 5), county soil survey reports, and field tests. As noted in table 1, the variety test and PI yields are reasonably close for corn and soybeans. The only major discrepancy is for wheat yields.

Local cash prices received at harvest were used to estimate crop prices. These seasonal average price series were adjusted to the 1981 level using the index of prices received for all crops by Ohio farmers. The use of an all-crops price index tends to dampen the harvest-season price variability actually experienced; however, to the extent that farmers adopt various price stabilization measures such as contracting, hedging, spreading sales, and government programs, unadjusted harvest prices would overstate variability. Given these offsetting influences, the indexed series used here is thought to be a realistic proxy for year-to-year price variability.

Gross margins for the three crops were computed annually by multiplying the yield (from the variety test series) by the inflation adjusted prices received and subtracting variable production costs obtained from the 1981 Ohio State University Crop Enterprise budgets for corn, soybeans, and wheat. Since expenses are largely known just prior to the planting season when the insurance decision is made, it was assumed that production costs were fixed; hence changing yields and prices are the only sources of variation in the gross margins. In plans where crop insurance coverage was purchased, gross receipts were increased by the amounts of any indemnities received, and variable costs were increased to reflect premiums paid.

The first phase of the analysis was to model a base farm plan with no crop insurance for a typical, 600-acre crop farm in northwest Ohio. Minimum acreage restrictions were imposed on each of the three crops to represent, as closely

Table 1. Variability in Yields, Prices, and Gross Margins of Corn, Soybeans and Wheat, Northwest Ohio, 1972-1981.

	Corn			Soybeans			Wheat		
Year	(1) Test Yield	(2) Price[a]	(3) Gross Margin[b]	(4) Test Yield	(5) Price[a]	(6) Gross Margin[c]	(7) Test Yield	(8) Price	(9) Gross Margin
	(bu./ac.)	($/bu.)	($/ac.)	(bu./ac.)	($/bu.)	($/ac.)	(bu./ac.)	($/bu.)	($/ac.)
1972	148.3	3.00	271	53.2	7.58	295	80.8	3.21	157
1973	152.5	2.97	279	34.9	7.14	141	46.4	4.83	122
1974	78.9	3.62	112	31.8	8.21	153	76.2	4.32	227
1975	170.3	2.99	336	60.9	6.12	265	68.2	4.17	182
1976	157.3	2.70	251	50.5	7.14	288	45.2	3.74	66
1977	146.4	2.31	164	55.4	6.45	249	62.9	2.47	53
1978	115.1	2.58	123	44.6	7.91	245	61.4	3.79	130
1979	166.9	2.89	309	53.6	7.71	305	73.2	4.79	248
1980	170.3	3.32	392	55.4	8.42	358	75.9	4.26	221
1981	117.7	2.44	113	27.1	6.22	61	51.3	3.53	79
Mean	142.4	2.88	236	46.7	7.36	236	64.1	3.91	148
Std. Dev.	29.7	.40	101	11.6	0.83	91	12.9	0.72	70
Min.	78.9	2.31	112	27.1	6.12	61	45.2	2.47	53
Max.	170.3	3.62	392	60.9	8.42	358	80.8	4.83	248
Coeff. of Var. (%)	20.8	13.9	42.8	24.8	11.3	38.6	20.1	18.4	47.3
Addendum - Comparative yield data									
County Ave. 1972-1981	103.0			31.4			47.6		
FCIC Area Yields	98.7			31.3			44.0		
Productivity Index	135.0			46.0			48.0		

[a]Adjusted to 1981 dollars using index of prices received by Ohio farmers for all crops.

[b]Col. (1) × Col. (2) minus variable cost per acre of $173.70, rounded to nearest whole dollar.

[c]Col. (4) × Col. (5) minus variable cost per acre of $107.98, rounded to nearest whole dollar.

[d]Col. (7) × Col. (8) minus variable cost per acre of $102.58, rounded to nearest whole dollar.

as possible, a realistic farm organization for that area. These minimum acreages, 108 acres for corn, 123 acres for soybeans, and 69 acres for wheat, reflect the actual allocation of total acreage to these three crops in Wood County. In addition to these minimum acreage constraints, the model was further constrained to a 1.14 to 1 soybeans to corn-acres ratio, also based on historic experience in Wood County.

The minimum acreage and soybeans to corn-acreage ratio constraints essentially forced the MOTAD model to generate only diversified cropping plans. Some diversification among these three crops is the norm in northwest Ohio. Farmers diversify to reduce risk and to better utilize labor and machinery throughout the year. The constraints also eliminate the generation of unrealistic solutions that are a common problem in analyses of this type.

Results

Gross Margin Variability

Table 1 contains yields, inflation-adjusted prices, and gross margins for the three crops for the period 1972 to 1981. Based on mean gross margins per acre, corn and soybeans were equally profitable plus they were significantly more profitable than wheat. It should be noted that the sale or home use of wheat straw was not considered. According to the enterprise budgets, sale of the straw would add approximately $40 per acre to the gross margin for wheat. The coefficients of variation for the gross margins indicate that wheat involves the most risk, followed by corn and soybeans. The higher variability of soybean yields is more than offset by the much lower soybean price variability.

Casual observation of the price and yield data reveals much about the risks facing crop producers. Corn growers with yields the same as the variety tests would have experienced very low returns to fixed factors in 1974, 1978, and 1981. In all three years, below-average yields were the major factor, and a virtual disaster was avoided in 1974 only by unusually high corn prices. At the other extreme, gross margins were well above average in 1975, 1979, and 1980 due to a fortunate combination of above-average yields, and in 1975 and 1979, above-average prices. Similar observation can be made for soybeans and wheat. As a risk management strategy, crop diversification can be a success some years and a failure in others. Low returns caused by poor corn and soybean yields in 1974 were partially offset by the above-average yield and price for wheat. In 1981, however, all three crops had below-average yields and prices.

The intuitive conclusions about diversification are confirmed by the correlation matrices for prices, yields, and gross margins in table 2. The r^2s indicate that corn, soybean, and wheat prices are all positively correlated over time; however, the r^2s for wheat and soybean prices are comparatively low. Corn and soybeans are affected by similar hazards, so it is not surprising to observe that their yields are highly correlated. Soft red winter wheat, with its very different seasonal production pattern, offers potential gain from diversification. Wheat yields are only moderately correlated with soybean yields, and are virtually independent of corn yields. In practical terms, if the corn crop is below average, then there is a 50 percent chance that the wheat crop will be above average. The correlation coefficients for the gross margins confirm that a wheat crop has the potential to mitigate the yield and price risks of a corn-soybeans rotation.

Table 2. Correlation Matrices

Level	Corn Insurance	Soybeans Insurance	Wheat Insurance
A. Prices			
Corn	1.00	0.58	0.60
Soybeans		1.00	0.36
Wheat			1.00
B. Yields			
Corn	1.00	0.75	−0.02
Soybeans		1.00	0.40
Wheat			1.00
C. Gross Margins			
Corn	1.00	0.68	0.43
Soybeans		1.00	0.35
Wheat			1.00

Base Model

Panel A in table 3 contains MOTAD-generated efficient farm plans determined under the acreage constraints described earlier. These acreage constraints restricted the MOTAD solutions to generally diversified farm plans with expected gross margins ranging from $110,000 to a maximum possible $135,321. In

Table 3. Summary of Risk Efficient Farm Plans

Enterprise	Unit	Expected Gross Margins ($1,000)						
		110	115	120	125	130	135	GM[a]
Corn	acres	113	139	166	193	220	246	248
Soybeans	acres	129	159	189	220	250	281	283
Wheat	acres	358	302	245	187	130	73	69
A. Base model								
Standard Deviation	($000)	41.6	42.3	43.9	45.5	48.7	52.1	52.3
Coefficient of Variation	(%)	37.8	36.8	36.6	36.4	37.4	38.6	38.6
B. 75% IYC, High Price Option[b]								
Standard Deviation	($000)	41.2	40.4	40.5	41.7	44.0	—	46.7
Coefficient of Variation	(%)	37.5	35.2	33.7	33.4	33.9	—	34.6
C. 80% IYC, High Price Option[b]								
Standard Deviation	($000)	40.0	39.5	39.0	39.2	41.1	43.5	44.0
Coefficient of Variation	(%)	36.4	34.4	32.5	31.4	31.6	32.2	32.3

[a]This is the farm plan maximizing gross margin.

[b]Acreages in panels B and C were almost identical to the base firm plan in panel A.

the absence of these constraints, total gross margin would have ranged from a low of $88,800 (600 acres of wheat) to a high of $141,600 from 600 acres of either corn or soybeans, both of which have gross margins of $236 per acre[1]

The acreage constraints did serve the purpose of restricting the set of feasible plans to those that are more typical in northwest Ohio. They also forced the model to generate farm plans that differ little on the basis of risk relative to income, as indicated by the nearly identical coefficients of variation. However, marginal risk—the increment in standard deviation divided by the corresponding increment in gross margin—increases as one moves up the frontier, from 0.16 over the gross margin range $110,000 to $125,000 to 0.66 over the range $125,000 to $135,321.

Effects of FCIC All-Risk Crop Insurance

Insurance options examined were the 75 percent area yield plan, 75 percent IYC, and two hypothetical higher coverages, 80 and 90 percent IYC. For all coverages it was assumed that the highest available price options were selected. Premiums for the 75 percent yield plans were the ones actually charged by FCIC for the 1982 crop year (see table 4). As is apparent from table 4, the subsidized, 75 percent area yield coverage premiums were not actuarially feasible, given the claims experience of the case farm. Average premiums would have fallen short of average indemnities per acre per year by $2 on corn and $3.08 on soybeans. The premiums on wheat would have been $3.20 per acre above average yearly indemnities. In view of these discrepancies, an attempt was made to calculate actuarially feasible unsubsidized premiums for the 75, 80, and 90 percent IYC coverages using the normal curve approach described by Botts and Boles. Briefly, their procedure estimates the average loss or indemnity for those years in which actual yields are below guaranteed levels, assuming that crop yields are normally distributed.

Area Yield Plan

As the data in table 4 indicate, crop producers with yields equal to the variety performance tests would have collected no indemnities from 1972 to 1981, yet they would have paid cumulative premiums of more than $29,000 over the ten-year period[2] The reason is that

[1]The optimal solution to the unconstrained problem is 600 acres of soybeans because the gross margin for corn is more variable.

[2]Based on a 600-acre farm (193 acres of corn, 220 acres of soybeans, and 187 acres of wheat) that generates a mean gross margin of $125,000 per year. Premiums paid are based on 75 percent coverage and top price options with the government subsidy and reductions for no claims in consecutive years.

the FCIC's maximum (75 percent) coverage levels are all below the minimum test yields recorded during the ten-year period. Minimum test yields (and the year they occurred) were 78.9 bushels per acre (1974) for corn, 27.1 bushels per acre (1981) for soybeans, and 45.2 bushels per acre (1976) for wheat—all well above FCIC's maximum coverage levels shown in table 1.

To counter the argument that test yields overstate a commercial producer's yields, the test yields were arbitrarily reduced by 20 percent, and yield variability was increased by 10 percent. With these assumptions, the corn yield was below the 74 bushel maximum coverage level only once—58.7 bushels per acre in 1974 when an indemnity of $45.90 per acre would have been collected. Only one indemnity would have been collected on soybeans: $24.50 per acre in 1981. No claims would have been collected on wheat. Over the ten-year period, total claims for the 600-acre farm would have been $14,249, less than half of total premiums paid.

A third evaluation of the area yield coverage plan was carried out using county average yields—103 bushels per acre for corn, 31.4 bushels per acre for soybeans, and 47.6 bushels per acre for wheat. The county average corn yield was below 74 bushels per acre in 1974, and would have generated an indemnity of $39 per acre. An indemnity of $9.80 per acre would also have been paid on soybeans in 1974. Again, no indemnity would have been paid on wheat. For a typical 600-acre farm that was producing county average yields, total indemnities over the ten-year period would have been $9,683 or about one-third of total premiums paid.

The IYC Option and Higher Coverage Levels

In this analysis, it was assumed that the test yields accurately represent the commercial producer's actual yield experience and that all ten years of yield data were documentable for the IYC option. Use of the minimum three-year average currently required by FCIC to qualify for IYC would have given means of 156.6 bushels per acre for corn, 45.4 for soybeans, and 66.8 for wheat. Coverage levels of 75 percent (the current maximum), and the two hypothetical higher coverage levels, 80 percent and 90 percent of mean yields, were examined (see table 4).

From the above average producer's standpoint, the IYC option makes FCIC all-risk insurance more attractive, even at the current 75 percent maximum coverage level with actuarially based, nonsubsidized premiums. It also appears that FCIC coverage could be even more popular if higher coverage levels were offered. Potential utility gains from 75 and 80 percent IYC coverage levels can be calculated by comparing panels B and C with panel A in table 3. At the $125,000 expected gross margin, 75 percent IYC coverage reduces the standard deviation by $3,800—an 8.3 percent reduction from the uninsured base farm plan. These gains occur even though the 75 percent IYC premiums were estimated from the ten-year test yields instead of the subsidized area average premiums the FCIC uses. The 80

Table 4. Premiums, Production Guarantees, and Claims Experience

	75% Area Yield[a]			75% IYC			80% IYC			90% IYC		
	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat
Premium ($/Acre)	6.10	4.80	5.20	9.60	7.60	3.10	11.69	9.78	4.90	18.00	18.80	10.28
Production guarantee (bu/acre)	74	23.5	33	106.0	35.0	48.0	113.9	37.4	52.3	128.0	42.0	57.7
No. of claims, 1972-1981	0	0	0	1	3	2	1	3	2	3	3	3
Ave. indemnity ($/ac/yr)	0	0	0	8.10	7.88	2.00	10.49	13.16	4.97	21.96	22.57	13.62
Ave. premium-Ave. annual indemnity ($/ac/yr)	6.10	4.80	5.20	1.50	(.28)	1.10	1.20	(3.38)	(.07)	(3.96)	(3.77)	(3.39)

[a]Includes 30 percent government subsidy on coverage up to 60 percent.
Price options (1982) were corn $3, soybeans $7, and wheat $4.50.

percent IYC coverage would further reduce the standard deviation by $2,500. The 80 percent IYC coverage would reduce risk by 13.8 percent compared to the base plan. Recall, however, that the soybean premium is less than the actuarially feasible level from the insurer's standpoint at the 80 percent level.

If added administrative costs are not considered, 75 percent IYC coverage is feasible from FCIC's standpoint for corn and wheat and nearly so for soybeans. The 80 percent IYC coverage is actuarially sound for corn and nearly so for wheat. The estimated annual soybean premium was $3.38 per acre less than the average yearly indemnity at the 80 percent coverage level. Average yearly claims would exceed average yearly premiums by a wide margin on all three crops at the 90 percent coverage level.

Summary and Implications

Implications for Producers

Crop producers whose yield experience is represented by the northwest Ohio variety test trials gain little in terms of risk reduction from the FCIC's area yield coverage plan. As noted earlier, no claims would have been collected during the period 1972 to 1981. If crop yields are normally distributed, the probabilities of realizing yields below FCIC's guarantees are only 2.3 percent for soybeans, 1.1 percent for corn, and 0.8 percent for wheat. The 75 percent IYC coverage significantly increases these probabilities to 15.6 percent for soybeans, 11.5 percent for corn, and 10.8 percent for wheat. The MOTAD model results also indicate potential utility gains. Moreover, 75 percent IYC coverage appears to be actuarially feasible from FCIC's standpoint.

Neither the comparison of premiums paid to indemnities received, nor MOTAD generated E-A frontiers completely explain the decision to insure. From the standpoint of the purchaser, insurance is the exchange of a small probability of a large loss for a small but certain loss—the premium. In fact, most buyers of casualty, liability, medical, and other types of insurance probably hope that they never have to file a claim. They buy insurance to protect their income streams and assets against large losses. The same reasoning can be applied to crop insurance. Some farmers buy crop insurance to prevent their incomes from falling below some "disaster" level in any given year, even though the probabilities of receiving indemnities are remote.

Consider the operator of our typical 600-acre crop farm that generates an expected gross margin of $125,000 per year. The MOTAD model results indicate that the standard deviation of this gross margin is $45,500 without crop insurance, $41,700 with 75 percent IYC, and $39,200 with the hypothetical 80 percent IYC coverage. Assuming a normal distribution for the gross margin, probabilities of receiving a gross margin below disaster levels ranging from $30,000 to $120,000 were calculated (see table 5).

The results appear to be at odds with the usual recommendations concerning crop insurance. High disaster levels are usually associated with high debt loads or other fixed financial obligations such as cash rent, wages for hired labor, and so forth. Some lenders encourage or require their highly indebted clients to purchase crop insurance; however, the relative gains in terms of reducing the probability of a disaster by purchasing crop insurance, are negligible at higher disaster levels. For the producer who needs a minimum gross margin of $100,000, for example, buying 75 percent IYC coverage decreases the probability of failure from 0.291 to 0.274—a modest 5.8 percent improvement in the odds of survival. The financially secure operator who needs only $50,000 achieves a relatively large 24 percent improvement in the odds by

Table 5. Probabilities of Realizing Gross Margins Below Disaster Level for a 600-acre Crop Farm With $125,000 Expected Gross Margin.

Disaster Level	No Insurance	75% IYC Insurance	80% IYC Insurance
($000)		Probabilities	
120	.456	.452	.448
110	.371	.359	.352
100	.291	.274	.261
90	.221	.201	.181
80	.151	.140	.125
70	.113	.093	.081
60	.076	.059	.049
50	.050	.038	0
40	.031	0	0
30	.018	0	0

purchasing the same insurance coverage. The insurance program would effectively rule out gross margins below about $43,100 and $50,450 for the 75 and 80 percent IYC coverages respectively. These minimums were calculated by assuming that yields for all three crops were exactly equal to FCIC guaranteed yields (i.e., no indemnities) and that prices were equal to the lowest values observed over the ten-year period. In Robinson's and Lev's terms, probabilities are "piled up" at these minimum amounts.

From the lender's standpoint, crop insurance is an appealing risk-reducing strategy. For the $100,000 disaster level operator, any gross margin below $100,000 implies financial failure of the business. In essence, all incomes below the disaster level are irrelevant to the borrower; however, all disaster levels are relevant for the lender because part of the loan may be recovered (Robinson and Lev). A $50,000 gross margin could result in a $50,000 loan loss on the $100,000 disaster level operation. However, the 75 percent IYC coverage reduces the probability of a loan loss exceeding $50,000 from 5 percent to 3.8 percent and would eliminate loan losses in excess of the minimum gross margins.

Implications for FCIC

The nationwide 75 percent upper limit on coverage appears to be a major impediment to increased participation by above average producers in low-risk farming areas. Conversely, any fixed ratio of coverage to mean yield may be too high in some areas and/or on some crops.

The recent implementation of the IYC and PRY options is an important innovation. These options should be widely publicized and offered because, over time, the yield data base will be enhanced by claims experience. This improved data base could then be used to test the actuarial feasibility of different coverage levels. Admittedly, the results of a case study cannot be generalized; however, they do identify some of the problems encountered in implementing more individualized crop insurance plans. Results of this study indicate that for our case farm 80 percent IYC coverage is probably feasible on corn and wheat, but not on soybeans. Our analysis also indicates that farmers under the IYC option should be charged different premiums than area yield plan participants. The 75 percent IYC premiums calculated from the ten-year variety test yields are substantially higher than area average premiums for corn and soybeans, but substantially lower for wheat. Discrepancies of this magnitude will jeopardize the IYC and PRY programs either through unfavorable claims experience or nonparticipation. Perhaps FCIC should consider using variety tests conducted by state experiment stations and the seed industry as a potentially useful source of additional crop yield data.

The broader questions concerning government's role in mitigating risks in agriculture need to be addressed (Kramer and Gardner). In the past yield and price risks have been addressed by different policies and largely autonomous agencies. The FCIC was created to reduce yield risk. Price risk has been addressed by various price support programs, such as the much publicized 1983 PIK program. The government has also played a major role in risk reduction through the FmHA's emergency loan programs. The combined budget outlays for these three USDA operations are sizable and very unpredictable. Perhaps recent proposals described by Heffernan to combine price and yield protection into a single farm revenue insurance program deserve serious consideration.

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Price-Level-Adjusted Mortgages for Agriculture and Index-Linked Bonds

J.A. Seagraves

Abstract

This article defines index-linked bonds and price-level-adjusted mortgages, explains how an intermediary could borrow money on the one basis and relend it on the other, and is intended to stimulate thought regarding desirability of partially-indexed mortgages. As an alternative, banks could allow use of land as security for cash management accounts or overdrafts.

Key words: index-linked, indexed, mortgages, inflation, cost-flow problems.

Economists have frequently recommended price-level-adjusted mortgages (PLAMs), price-level-adjusted deposits (PLADs), and index-linked bonds (ILBs) as ways to cope with uncertainty about future inflation rates. Writing in *Newsweek*, Friedman has recommended PLAMs and PLADs; however, he devotes many more articles to ways of stopping inflation than to ways of adjusting to it. Kahn has recommended indexing the principal. Helzel and Babbel and Sharplin have also recommended indexed borrowing.

These instruments guarantee lenders that they will be paid back amounts of money that have the same purchasing power as the money that they lent. Conventional bonds and mortgages assign the risk of increased inflation to the lender. It is hard to understand why mortgage contracts have not developed in which the risk of increased inflation is shared by the borrower and the lender. In the 1950s, for example, cities in Finland sold bonds with interest and principal linked to one-half of the change in consumer price index.

Inflation Rates and Interest Rates

Reported inflation rates refer to the past. They are called *ex post* rates by economists, and usually refer to a specific deflator or index. The consumer price index (CPI), for example, is based on a market basket of items that a typical family might have bought during some past base period. The gross national product (GNP) deflator is based on a changing market basket which reflects continual substitution away from items with higher-than-average price increases. Annual GNP deflator rates for recent years are given in the first column of table 1. They vary more than do the four-year

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Table 1. A Comparison of Some Inflation Rates and Mortgage Rates

	Inflation Rates			Mortgage Rates	
Year	Annual GNP Deflator Realized Rates	Long-Term Expected Future Rates[a]	Corporate Aaa Bond Rates[b]	Federal Land Bank Annual Equivalent Rates[c]	Commercial Bank Long-Term Real Estate[c]
1977	5.8	(6.5)	8.1 (1.6)	8.9 (2.4)	9.4
1978	7.3	6.2 (6.5)	8.7 (2.5)	8.8 (2.6)	9.4
1979	8.5	7.3 (7.3)	9.5 (2.2)	9.7 (2.4)	10.7
1980	9.0	8.7 (8.2)	12.0 (3.3)	10.9 (2.2)	13.7
1981	9.0	7.9 (8.7)	15.3 (7.4)	11.8 (3.9)	16.7
1982	6.7	6.8 (8.0)	14.7 (7.9)	13.0 (6.2)	16.7
1983	4.0	6.3 (6.5)	11.8 (5.5)	12.5 (6.2)	14.5
Selected Simple Averages	7.2	7.2 (7.4)	12.4 (5.3)	10.8 (3.7)	13.0

[a]Hoey's results from surveying about 500 decision makers in financial institutions are given. He asks them about their expected future inflation rates over the next ten years. This survey correctly identified the sharp turning point at the time of the election in November 1980. Numbers in parentheses are Sullivan's weighted average of current and recent past-year inflation rates of the GNP deflator where the weights are .4, .3, .2, and .1.

[b]Numbers in parentheses are the difference between corporate bond yields and long-term expected inflation rates.

[c]Averages calculated from LaDue's table 8. His source was Melichar and Balides.

moving average of these same rates given in parentheses in the next column.

Expected future inflation rates pose a much more difficult problem for the economist. Past rates are not good indicators of future rates. Macroeconomic models that take into account changes in the money supply, capacity utilization, foreign exchange, energy supplies, and other variables do a better job of predicting inflation than do past trends. Sometimes economists want to know the average of businessmen's expectations about inflation. Two methods are used to observe such expectations: surveys and the examination of interest rates in both spot and futures markets. Many economists have made successful use of the Livingston survey for expectations of six and twelve months.[1] One lesser-known set of survey results for expected future (ten-year) inflation rates is given in the second column of table 1. These survey results (*ex ante* rates) happen to have the same simple average for the seven-year period as the *ex post* GNP deflators, indicating that they may refer to similar indices. (Naive expected future rates, equal to a weighted average of current and past GNP deflator rates, are given in parentheses. They "missed" the turning point in November 1980, as would have been expected.)

Corporate Aaa bond rates, given in the third column of table 1, also reflect expected future inflation rates, but with a lag. They peaked in 1981 and have come down much more slowly than have the survey results for long-term expected inflation rates. Simple differences between these interest rates and the long-term expected inflation rates in column 2 are given in the parentheses next to the Corporate Aaa Bond rates. At least four factors logically could account for the large increase in these "real rates" from 2.2 percent in 1979 to 7.9 percent in 1982. First, Aaa bond rates are reported before taxes, and a 40 percent marginal tax levy would amount to 3.5 percent out of 8.7 percent in 1979, but 5.9 out of the 14.7 percent in 1982. Second, as inflation rates rose, uncertainty about future inflation rates also rose, contributing to a larger risk premium for inflationary uncertainty in 1982 than in 1979. Third, increased deficit spending and increased borrowing by consumers—caused by increased unemployment—could have caused real rates to rise.[2] Fourth, none of the price indices reflect change in wealth, as has been emphasized by Brown and Santoni. If real rates fall and asset values rise (as may have happened in the recession of 1982), both the CPI and the GNP deflators would underestimate the amount of inflation felt by wealthy people—people who may be

[1]See Peek and Wilcox as well as Wilcox, and work backward through references to Gibson.

[2]For example, see Elliott

disappointed when they have to shop for good investment opportunities after a fall in real rates.

Mortgage rates are given in the last two columns of table 1. Federal Land Bank rates are based on their costs of capital, which are based on a portfolio of Treasury bonds and Treasury bills with an average maturity of slightly more than three years. These "annual equivalent rates" are based on the net amounts borrowed—after subtracting the five or ten percent that the borrower must leave on deposit. Federal Land Bank (FLB) rates peaked at 13 percent in 1982, one year later than Corporate Aaa bonds peaked and two years after the peak of expected inflation rates. The average FLB lending rate for the seven years—10.8 percent—was well below the average long-term Aaa bond rate of 12.4 percent for the seven-year period. Also note that FLB rates were 2.8 percent under the average long-term mortgage rates charged by commercial banks. In effect, the Federal Land Banks pioneered the idea of variable rate mortgages (VRMs). A high percentage of the Commercial Bank loans would have been for fixed-rate mortgages (FRM), as late as 1982. FRM rates suffer two "disadvantages" compared to VRM rates in recent years. Under FRM, borrowers are guaranteed a fixed rate for the whole period of the loan, thereby protecting themselves against inflation; however lenders often are not protected against borrowers repaying loans if inflation and interest rates fall. The cost of this lopsided privilege is reflected in higher mortgage rates. In addition, FRMs involve a higher risk premium for uncertainty about expected future inflation rates. Banks have to borrow long in order to lend long or else they must charge a risk premium for borrowing short and absorb the risk of lending long themselves. In contrast, VRMs are long-term contracts in which the intermediaries simply promise to pass future short-term interest rates (and short-term expected inflation rates) onto the borrowers. The risk premia of long-term bonds are thereby avoided. Also, borrowers with VRMs will not be likely to refinance their mortgages in a period of disinflation; thus they avoid the premium for the lopsided guarantee inherent in FRMs.

People are now so aware of the average interest rate advantage of VRMs over time, and of the fact that VRMs assign the risk of fluctuations in short-term interest rates (and short-term expected inflation rates) to the borrowers, that there is a tendency to confuse them with price-level-adjusted mortgages, PLAMs, or to assume that the VRMs have the advantages of PLAMs. This assumption is not true. PLAMs should be thought of as real-rate loans starting off at three or four percent, with payments determined by the total elapsed inflation from the date of the loan. Besides having a much gentler repayment schedule in early years of the loan (being less "front-end loaded"), PLAMs might have a large tax advantage to borrowers in high marginal tax brackets.

Index-Linked Bonds

If a bank or the FLB were to issue PLAMs, which might involve a commitment to lend money for a long period of time at a real rate of about four percent, that intermediary would want to borrow money on similar terms, but at a real rate of about three percent. It probably would issue an index-linked bond (ILB). This section provides a definition and an illustration of an ILB and compares it with a conventional 11.75 percent nonlinked bond. The next section compares a PLAM with a conventional mortgage.

An ILB involves choosing an index—say the GNP deflator (of the new CPI)—and a base quarter (or month) prior to the date of issue on which all future payments will be based. If the first interest payment will be due six months after a bond is issued, and if interest payments need to be known in advance to facilitate transfer of bonds among persons (assume that sellers are to be reimbursed exactly for interest they have accrued to the date of sale), then it may be logical to pick a base quarter that falls two full quarters before the bond is issued.[3] For example, if the GNP deflators are announced in March, June, September, and December, and a bond is going to be issued in October, then basing it on the GNP deflator for March will allow investors to know the rate of inflation from March to September. Knowing the rate of inflation will permit them to calculate the interest that will be due the

[3]The British Treasury issues index-linked bonds based on the retail price indices eight months prior to the date of issue, plus the changes in the index between that date and dates eight months prior to each payment and to redemption.

following April. If a 30-year bond were to be issued in October 1985 and were to be based on the GNP deflator of March 1985 (say 230), then the redemption value of the bond would be based on the GNP deflator for March of 2015 (assume that it is 1321). The ratio of 1321 to 230 is 5.7435, and it equals $(1.06)^{30}$, impling a six percent annual rate of inflation. The bond, which will sell for about $1,000 in October 1985, would be redeemed in October 2015 at exactly $5,743.50, plus interest for the last six months. Assuming that it is a three percent bond paying 1.5 percent every six months, the interest payment would always be .015 times the value of the bond at the end of each interest period. For the last period it would be .015(5743.50) or $86.15.

Table 2 provides an assumed set of inflation rates for a 30-year period, plus annual payments for an 11.75 percent conventional bond and payments for a comparable three percent index-linked bond[4]. How can we say that the yields on these bonds are comparable? We assume that the average annual compounded rate of inflation is 6.846 percent and that lenders demand 1.5 percent extra when they must bear the risk of increased inflation[5]. In other words, we justify the 11.75 percent coupon on the conventional bond by combining these assumptions using the compound interest formula:

one plus the real rate	×	one plus the inflation rate	×	one plus the risk premium	=	one plus the nominal rate
(1.03)	×	(1.06846)	×	(1.015)	=	(1.1170)

[4]This example is a modification of one used by Helzel and Babbel and by Sullivan.

[5]Sullivan develops this argument and the rationale for the 1.5 percent risk premium. The risk premium is estimated from the term structure of interest rates (yields on T-bonds and T-bills) one year ahead from the futures market. The futures market is used because it is highly liquid and offers homogeneous "commodities" that are standardized substitutes for actual bonds and bills. By going one year ahead, we avoid the swings in nearby short-term rates. From September 1981 to September 1983, this term structure fluctuated from about zero to 2.5 percent and averaged about 1.5 percent. If we assume no term structure in expected inflation rates and no term structure in real rates, then most of this 1.5 percent must be explained as a risk premium. At best, this is a very rough way to estimate the difference in the yield of conventional and index-linked bonds. See Weiner and a recent book by Dornbush and Simonsen.

The nominal interest cost of $117.50 per year for the conventional bond covers, in a sense, the expected year-by-year deterioration in real value of the principal. It is not until the twenty-third year that the interest payments for the ILB begin to exceed those of the conventional bond. The simple sum of the interest payments for the ILB, $2,550, is only 72 percent of the sum of the 30 payments of the conventional bond. The final redemption value of $7,290 for the ILB may seem formidable, but remember that it represents the same purchasing power as did the original $1,000 30 years earlier. The simple sum of the amounts paid back in the case of the ILB, $10,060, is 2.3 times greater than the amount paid back on the conventional bond; however much more money is being borrowed toward the end of this loan.

One way to compare widely different sums paid at different times is to calculate present values based on one set of discount rates. Present values are given in the last row of table 2 and in table 3. The discount rates used to calculate these present values are the anticipated inflation rates for each year plus 2.5 percent (assumed to represent the short-term opportunity costs of capital). The average discount rate for the 30-year period is 9.34 percent, which is less than the yield of the conventional bond. Hence, the present value of the money that must be paid back, $1,260, is greater than the $1,000 lent. The present value (or cost) of the ILB is only $1,150. Other discount rates could be used to calculate present values. At a rate of 11.75 percent, the conventional bond would have a cost of $1,000, and the ILB would cost less than $1,000. At a discount rate of 8.1 percent (the Fisher rate), both bonds have the same present value.

Besides comparing the pattern of payments, amounts borrowed, and the present values of these two bonds, we should (1) note the differences in present values after taxes; (2) note the differences in risks to the lender; and (3) consider making the durations rather than the maturity dates comparable. The increases in principal on an ILB due to inflation are not actually paid by the borrower until the bond matures; nevertheless it is easy to calculate the change in the redemption value each year. It would be advantageous for the borrower to consider these increases in liabilities as expenses for tax purposes. After considering

Table 2. A Hypothetical Example of a Conventional and an Index-Linked Bond Based on Assumed Future Inflation Rates: Cash Flows and Present Values

Year	Assumed Annual Inflation Rates[a]	Annual Costs of Borrower Before Tax Deductions for: Conventional 11.75% Bond	Index-Linked 3% Bond[b]	Annual Gains in Value of Indexed Bond	Cash Flows for Indexed Bond after Taxes of 50% Are Paid[c]
0	.083	−1000.00	−1000.00	—	−1000.00
1	.079	$117.50	32.49	83.00	−25.26
2	.069	117.50	35.05	85.56	−25.25
3	.095	117.50	37.48	80.63	−21.58
4	.103	117.50	41.04	118.67	−38.82
5	.084	117.50	46.26	140.89	−47.81
6	.078	117.50	49.06	126.74	−38.84
7	.071	117.50	52.89	127.57	−37.34
8	.066	117.50	56.65	125.18	−34.26
9	.050	117.50	60.38	124.62	−32.12
10	.041	117.50	63.40	100.64	−18.62
11	.063	117.50	66.00	86.65	−10.32
12	.010	117.50	70.16	138.61	−34.22
13	−.025	117.50	70.86	23.39	+23.74
14	.004	117.50	69.09	−59.05	+64.07
15	.027	117.50	69.37	9.21	+30.08
16	.040	117.50	71.24	62.43	+4.40
17	.048	117.50	74.09	94.99	−10.45
18	.060	117.50	77.65	118.55	−20.45
19	.075	117.50	82.31	155.30	−36.50
20	.081	117.50	88.48	205.77	−58.64
21	.115	117.50	95.65	238.90	−71.62
22	.129	117.50	106.65	366.65	−130.00
23	.144	117.50	120.40	458.58	−169.09
24	.100	117.50	137.74	577.94	−220.10
25	.080	117.50	151.52	459.14	−153.81
26	.070	117.50	163.64	404.04	−120.20
27	.073	117.50	175.09	381.82	−103.36
28	.068	117.50	187.87	426.06	−119.09
29	.090	117.50	200.65	425.85	−112.60
30	.083	117.50	218.71	601.95	−191.62
Redemption Value in 30th Year		1000.00	7290.25	—	7290.25
Total Payment in 30th Year		1117.50	7508.96	—	7019.63
Simple Sum of Amounts Paid Back		4525.00	10,060.00	—	5430.57
Present Value of Amounts Paid Back[d]		1260.00	1150.00	—	151.00

[a]These are the same as the inflation rates assumed by Helzel and Babbel (*op. cit.*). The average annual compounded rate is .068459, regardless of whether one goes from year zero to 29 or year one to 30.

[b]The inflation rate for year zero is assumed to refer to the year ending a month before time zero, the date when the bond is issued. A lag is assumed so that interest on the index-linked bond for the next payment period can be calculated in advance. The first interest payment is made at time one (the end of year zero or the beginning of year one). Interest payments pertain to money borrowed during the preceding period, but the payments are based on the end-of-period redemption value of the bond. For example, the value of the bond at the beginning of year one is $1,083 because the inflation rate for year zero was .083. The interest due at time one is three percent of $1,083, or $32.49. The gain in the value (or the liability) of the bond during the preceding year is listed in the next column.

[c]The interest payments are reduced by 50 percent, and 50 percent of the annual gains in the value of the indexed bond are subtracted, resulting in annual costs to the borrower which are usually negative.

[d]The reason that these present values are not exactly equal to the amounts borrowed ($1,000), as would be true of *ex ante* present values, is that these are *ex post* calculations based on pretending knowledge of inflation rates 30 years into the future to calculate present values for year zero. The discount rates used to calculate present values were the inflation rates for the year ahead plus .025. To discount payments from time one to present values at time zero, 10.4 percent (from .079 + .025 = .104) was used.

Table 3. After-Tax Present Values of Repayments for the 30-Year Conventional Bond from Table 1 and Comparable Index-Linked Bonds with 30-Year and Shorter Maturities

Item: Marginal tax rate	Conventional 30-year bond	Index-linked bonds with the increase in principal deducted as an expense each year: 30-year bond	15-year bond	10-year bond
Present values in year zero:[a]				
Zero	1260	1150	1127	1058
25 percent	962	651	852	850
50 percent	664	151	577	643
Durations:[b]				
Zero	8.7	20.8	12.5	8.8
25 percent	9.1	26.4	14.5	9.7
50 percent	9.8	(30)[c]	(15)[b]	(10.0)[c]

[a]See footnote d of table 2 for explanation of discount rates used.

[b]The "duration" of the repayments is the weighted average year in which the repayments are made. The weights are the ratios of the present values of each repayment to the present value of all repayments.

$$\text{Duration} = \sum_{t=1}^{T} t\,A(t)/\prod_{t=1}^{t}(1-d(t)) \div \sum_{t=1}^{T} A(t)/\prod_{t=1}^{t}(1-d(t))$$

where t indicates the year, A(t) is the after tax payment in each year, and Π indicates the product of the annual discount rates d(t) which are defined in footnote d of table 1.

[c]The number in parentheses is the maturity (years) of the bond. The formula for duration given in footnote b results in a duration that is longer than the maturity so the latter is used.

alternative ways that the increase in principal could be deducted (either as expenses each year or as an expense or a capital loss in the final year), the author concluded that the IRS would accept as annual expenses these increases in liabilities for borrowers reporting on an accrual basis.[6] Also, annual expensing is consistent with treatment of zero coupon bonds under TEFRA.

A long-term index-linked bond would have a tremendous advantage over a conventional bond for borrowers in a high marginal tax bracket. Note in the second column of table 3 that the present value or cost of $15 per $1,000 borrowed on the ILB is less than one-fourth the cost of the conventional bond, and about one-eighth of the value of the same bond to someone in the zero tax bracket. These figures make it very difficult to explain why ILBs have not been used and why their tax status has not been clarified.

If there is any risk of default, then the two 30-year bonds would have different risks to the lender. The lender who buys an ILB is gradually lending more nominal dollars until the date of maturity; hence his exposure in the event of default is greater. At the same time, the purchasing power of what he loans is protected from the ravages of increased inflation. If there is no risk of default, then the ILB is the less risky of the two bonds. At some level of default and inflation risk, the two bonds are equally risky. With high levels of default risk, no one would consider ILBs.

Killingsworth suggested that the "durations" of the two bonds should be made comparable, rather than their maturities. Duration is defined here as the weighted average year in which the money is returned. (For a precise definition, see footnote b of table 3.) The duration of the 30-year conventional bond with zero taxes is 8.7 years, as opposed to 20.8 years for the ILB.

The longer duration of an ILB is mainly an advantage when it is first introduced. Delayed repayment schedules would be important to beginning farmers with "cash flow" problems and to countries that must consolidate all their borrowing into one big loan. The advantage of longer durations evaporates when a series of ILBs is maturing regularly or being "rolled over" into new loans. Note that in the final column of table 2 where the increases in liabilities are expensed each year and the 50 percent tax bracket is assumed, the net costs of the loan to the borrower are negative in 26 of the 30 years; the duration of the loan is effectively 30 years.

Table 3 also shows the present values and durations of ILBs that mature in 10 and 15 years. The 10-year ILB has about the same duration as the 30-year conventional bond at these interest rates. Equalizing durations completely wipes out the tax advantage of ILBs to borrowers. At high tax rates, the ILBs no longer have lower present values than the conventional bonds. This is because as the duration is shortened, redemption values gain in importance relative to the deductible

[6]See Seagraves.

Table 4. Repayment Schedules for a Four Percent 30-year Mortgage and for a Price-Level-Adjusted Mortgage Based on It

	4% Conventional Mortgage-No Inflation				Compounding Factors for Inflation, 1 Plus the Cumulative Rate[a]	Price-Level-Adjusted Mortgages				
Year	Total Annual Payments	Interest Payment	Principal Payment	Principal Balance		Total Annual Payment	Interest Payment[b]	Principal Payment[b]	Principal Balance[c]	Increase in the Value of the Principal[d]
0	—	—	—	1000.00	1.00000	—	—	—	1000.00	—
1	57.83	40.00	17.83	982.17	1.08300	62.63	43.32	19.31	1063.69	83.00
2	57.83	39.29	18.54	963.63	1.16856	67.58	45.91	21.67	1126.05	84.03
3	57.83	38.54	19.28	944.34	1.24919	72.24	48.15	24.09	1179.66	77.70
4	57.83	37.77	20.06	924.29	1.36786	79.10	51.67	27.43	1264.29	112.07
5	57.83	36.97	20.86	903.43	1.50875	87.25	55.78	31.47	1363.04	130.22
6	57.83	36.14	21.69	881.73	1.63548	94.58	59.10	35.48	1442.06	114.50
7	57.83	35.27	22.56	859.17	1.76305	101.96	62.18	39.78	1514.77	112.48
8	57.83	34.37	23.46	835.71	1.88823	109.20	64.89	44.30	1578.01	107.55
9	57.83	33.43	24.40	811.31	2.01285	116.40	67.29	49.12	1633.04	104.15
10	57.83	32.45	25.38	785.93	2.11350	122.22	68.59	53.64	1661.06	81.65
11	57.83	31.44	26.40	759.54	2.20015	127.24	69.17	58.07	1671.09	68.10
12	57.83	30.38	27.45	732.09	2.33876	135.25	71.05	64.20	1712.18	105.28
13	57.83	29.28	28.55	703.54	2.36215	136.60	69.17	67.43	1661.87	17.12
14	57.83	28.14	29.69	673.85	2.30309	133.19	64.81	68.38	1551.95	−41.55
15	57.83	26.95	30.88	642.98	2.31230	133.72	62.33	71.40	1486.76	6.21
16	57.83	25.72	32.11	610.87	2.37474	137.33	61.08	76.26	1450.65	40.14
17	57.83	24.43	33.40	577.47	2.46973	142.82	60.35	82.48	1426.19	58.03
18	57.83	23.10	34.73	542.74	2.58827	149.68	59.79	89.89	1404.76	68.46
19	57.83	21.71	36.12	506.62	2.74357	158.66	59.56	99.10	1389.94	84.29
20	57.83	20.26	37.56	469.05	2.94934	170.56	59.77	110.79	1383.40	104.25
21	57.83	18.76	39.07	429.99	3.18823	184.38	59.82	124.56	1370.90	112.06
22	57.83	17.20	40.63	389.36	3.55488	205.58	61.14	144.44	1384.11	157.65
23	57.83	15.57	42.26	347.10	4.01346	232.10	62.51	169.59	1393.07	178.55
24	57.83	13.88	43.95	303.15	4.59140	265.52	63.75	201.77	1391.90	200.60
25	57.83	12.13	45.70	257.45	5.05054	292.07	61.24	230.83	1300.26	139.19
26	57.83	10.30	47.53	209.92	5.45458	315.44	56.17	259.27	1145.01	104.02
27	57.83	8.40	49.43	160.48	5.83640	337.52	49.01	288.51	936.65	80.15
28	57.83	6.42	51.41	109.07	6.26246	362.16	40.20	321.96	683.07	68.38
29	57.83	4.36	53.47	55.61	6.68830	386.78	29.18	357.60	371.91	46.45
30	57.83	2.22	55.60	−0.00	7.29025	421.60	16.22	405.38	−0.00	33.47
Simple sums			1000.00					3638.20		2638.20
Present Values	1268[e]	561[e]	649[e]			1312[f]	580[f]	674[f]		876[f]

[a]The products of one plus the assumed annual inflation rates from table 2.

[b]The cumulative inflation factor times the corresponding earlier columns for the four percent conventional mortgage.

[c]New outstanding balances are the balance due in the preceding year times one plus the inflation rate for that year from table 2 minus the principal payment.

[d]The annual increase in the balance due is simply the preceding year's balance times the interest rate for that year from table 2.

[e]Based on an assumed annual discount rate of .025 or a discounting factor of $1/(1 + .025)^t$.

[f]Present values are found using the same annual discount rates as in table 2—the inflation rates for each year plus .025.

interest and losses on principal. It might seem as though the 10-year ILB has practically no advantages over the 30-year conventional bond. That conclusion is not valid. The ILB would still have much gentler cash flow requirements for the borrower in the early years, and it would still insulate the lender from the vicissitudes of rising inflation rates.

Price-Level-Adjusted Mortgages

A PLAM is a mortgage. As such, it is gradually amortized over the life of the loan. The first three columns of table 4 list total annual payments, interest payments, and principal payments for the amortization over a 30-year period of a $1,000 loan at four percent. This real rate of four percent would be a reasonable mortgage rate if no inflation were expected. Therefore, it is a reasonable basic real rate for a PLAM. The same inflation rates assumed in table 2 are used to calculate the compounding factors for inflation which are listed in column 5 of table 4. These inflation factors for each year are multiplied by the first three columns of table 4 to obtain the corresponding three series for the PLAM with inflation (see columns 6, 7, and 8). The principal balance in column 9 increases gradually until the twelfth year of the loan and then declines. The increase in the amount of the loan might be disconcerting to a banker who is preoccupied with collateral. Presumably, however, land values would also be increasing, and the banker would be reporting to the borrower each year the precise increases in the value of his debt due to inflation (column 10)—as well as interest payment, payment toward principal reduction, and net principal due.

Let us assume that the Internal Revenue Service agrees that annual increases in the value of one's debt due to inflation (column 10) may be considered expenses for income tax purposes. Only part of these increments is being repaid during the first twelve years, but principal payments exceed the increases in principal in most of the subsequent years. The important consideration—from the standpoint of the IRS—is that the original $1,000 borrowed is not being "expensed." The sum of the principal payments in column 8 is exactly $1,000 more than the sum of the annual increments in column 10. However, the time pattern of these series is quite different. Note, in the last row of table 4, that the present value of the tax-deductible increases in value due to inflation, $876, exceeds the present value of principal payments, $674.

Table 5. Present Values and Durations of Conventional and Price-Level-Adjusted Mortgages

	Conventional Mortgages		PLAMs	
Item	(FRM) 12.787%	(VRM) 11.12%	4% plus cumulative inflation[a]	4% with no inflation
Annual Payments	$131.42	$116.11	$62.63 to 421.50	$57.83
Present values of repayments for a borrower in these marginal tax brackets:[b]				
Zero	1465	1293	1312	1268
25%	1174	1045	948	1128
50%	883	797	584	988
Durations of the mortgages given these marginal tax brackets:				
Zero	9.1	9.1	13.1	13.0
25%	9.2	9.2	14.3	13.4
50%	9.3	9.4	17.1	13.8

[a]This PLAM is defined in the last five columns of table 4.

[b]See footnote d of table 2.

Continuing this game of pretending that we know inflation rates 30 years into the future—or that we know that the average annual rate will be 6.846 percent—what interest rates should we assume in order to devise comparable conventional mortgages? In table 5 we have assumed that 12.787 percent is a comparable rate for a conventional fixed-rate mortgage, and that 11.12 percent would be a comparable average rate over the 30 years for a variable rate mortgage, or VRM.[7]

Again, the borrower and lender will use several different criteria in deciding which of these mortgages each prefers. Yield and risk are once again the paramount considerations. The yields to the lender are 12.787 percent for the fixed-rate mortgage, and 11.12 percent for the variable rate mortgage and the PLAM. As the lender's yield declines, so does his risk. The opposite is true for the borrower; as he obtains a lower interest rate, he assumes more

[7]The *ex post* yields on the PLAM and the VRM are assumed to be the same—11.12 percent (1.04 × 1.6846 = 1.1112). The yield on the FRM (12.787 percent) is assumed to include a risk premium of 1.5 percent. It is derived from 1.1112 × 1.015 = 1.12787.

of the risk of higher inflation rates in the future.

The present values emphasize exactly what we saw earlier—that index linking would have great advantages to a borrower who is in a high marginal tax bracket. In the zero tax bracket, the present value of the amounts repaid on the VRM is $1,293, as opposed to $1,312 for the PLAM; therefore the VRM would be slightly preferred.[8] However, a borrower in the 50 percent tax bracket would reap a $213 per $1,000 advantage in terms of present values by using a PLAM instead of a VRM ($797 − $584 = $213).

The durations of the conventional mortgages shown in the lower portion of table 5 are similar to the durations of the conventional 30-year bond shown in table 3. Basically, if interest rates are above ten percent, it is difficult for a conventional loan—even one of 100 years—to have a duration of more than about ten years. This is not true of PLAMs. They would have about the same duration regardless of the inflation rate (ignoring taxes). PLAMs do have much shorter durations than ILBs, because in the case of the ILB, none of the principal is repaid until the end of the loan. If the Federal Land Bank wanted to issue ILBs with durations that were comparable to the durations of 30-years PLAMs, it would probably choose 15-year ILBs.

What type of farmer would be expected to prefer PLAMs over conventional VRMs? The answer: risk-takers in high brackets who have a cash-flow problem. Of course, banks may be reluctant to make long-term real rate loans unless they have good collateral that will increase in value with the amount borrowed.

Why Haven't PLAMs and ILBs Been Used in the United States?

At the same time that many economists have been recommending PLAMs, others have been asking why they haven't already been used.[9] What follows is a set of tentative answers to this question.

Inflation may not have been volatile enough to cause people to diligently seek ways to protect themselves against it. As long as we were on some form of the gold standard—or until 1968—long-term expected inflation rates generally were less than two percent. Now, in early 1984, my long-term expected inflation rate is six percent with a standard deviation of five percent.[10] The higher the volatility of inflation rates, the greater would be the demand for PLAMs. If inflation and its standard deviation drop to zero, there will be no risk premium and no need for PLAMs or ILBs.

The time may never have been right for index-linked bonds in the United States. Real rates expected on nominal contracts may have been too high in 1981-1982 and too low from 1934 to 1980.[11] If we assume that ILBs would need to have a coupon offering a real three percent before taxes, and we add a risk premium of 1.5 percent, then the expected real return on long-term nominal bonds ought to be about 4.5 percent—say four to five percent—in order for both ILBs and conventional bonds to sell in competition with one another. If fact, 1983 and early 1984 may be characterized by expected real rates before taxes in this range.[12]

Not enough incomes are indexed in the United States. The more that borrowers' net incomes

[8] I did not actually hypothesize a set of variable rates over the 30-year period. Such a hypothesis would be rather complicated, since one would have to decide how to derive comparable variable rates. They are much smoother than inflation rates (see table 1). Also, the schedule of principal payments is being changed every time the contract rate changes for the VRMs issued by the Federal Land Banks.

[9] Another group is saying that the benefits of indexed financial instruments have been exaggerated.

[10] My standard deviation refers to annual rates which I expect to see over the next 30 years. It corresponds to a range from zero to 20 percent.

[11] According to McCullock, the "Gold Clause" in the Joint Congressional Resolution of June 5, 1933, effectively made index-linked contracts illegal until October 1977 when "Congress, thinking it was merely humoring a handful of 'gold bugs,' passed the Helms Amendment which revoked the 1933 Joint Resolution." For a different interpretation, see Rosenn, "Protecting Contracts from Inflation," *The Business Lawyer* (January 1978), pp. 740-741.

[12] Hoey subtracts his 10 years expected inflation rates from ten-year T-bond yields. His real rates are: September 1978-October 1980, below 2.68 percent; January 1981, 4.32 percent; May 1981-September 1982, above 5.61 percent; December 1982, 3.94 percent; March 1983, 4.15 percent.

are indexed, the more they will be willing to use PLAMs. The more lenders' incomes are indexed, the less enthusiastic they will be about indexed lending. The more that incomes and prices are indexed, the lower will be the real rate paid on PLAMs and the larger will be the risk premium between the nominal yield on conventional mortgages and the realized yield on PLAMS.

No appropriate price index exists. Cukierman reminds us that increased volatility of overall inflation rates is usually associated with increased volatility among real prices. Thus a price index that is attractive to borrowers may not suit lenders, and vice versa. Brown and Santoni remind us that none of our price indices accurately reflects changes in wealth.

There are too many good alternatives. Bodie, Kane, and McDonald develop the argument that short-term T-bills provide investors with extremely low-risk asset. Real yields are almost constant. Borrowers using VRMs are avoiding the risk premium for inflation inherent in long-term rates. Lenders have an effective substitute for ILBs that protects them from inflation.

Start-up costs are high. These costs could include uncertainty about how increases in principal will be taxed, higher interest rate payments because the buyers of ILBs would not be competitive at first, and the cost of designing and advertising the instruments. Perhaps there is "determined resistance" to PLAMs and ILBs in the financial markets, but that notion cannot be true if these markets are highly competitive. One of the purposes of this article is to reduce start-up costs by stimulating discussion of PLAMs.

The author is asking the same question in England. There, most farmers that do borrow use overdrafts with commercial banks for both short- and long-term financing. They pledge their farms as collateral for these indefinite-term callable loans with completely flexible repayment schedules. Four large banks compete in terms of how much more than the base (prime) rate they will charge an individual farmer. Overdrafts also have the advantage of allowing income-tax deductions of interest even in years when no interest is paid. Overdrafts and direct placements have virtually eliminated the issue of new corporate bonds. In effect, there appears to be little need for PLAMs in Great Britain.[13]

Conclusions

Farmers have been well-served by the variable-rate mortgages of the Federal Land Banks. But farmers with low equities may need gentler repayment schedules during the early years of their loans than is customary under existing mortgages. Flexible use of refinancing and grace periods is used to provide relief on a case-by-case basis. Price-level-adjusted mortgages would provide a more rational long-run solution to the cash-flow problems caused by inflation, especially for firms with low equity and low rates of real growth. I think the Federal Land Banks should consider experimenting with mortgages that are 50-50 combinations of PLAMs and VRMs.

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[13]See Rutherford. Also, Hill emphasized the need for noncallable loans that will help farmers with a cash-flow problems. Conventional loans may require the borrowers to make burdensome repayments of real principal in the early years of a loan. In an example, he assumes: (1) a project (machine) with a known annual real return of five percent and various expected lifes, (2) nominal returns to retire the maximum possible amount of the cost each year, and (3) inflation rates of zero and fifteen percent. Inflation creates no problem. The pattern of repayments would be identical for a farmer using an overdraft and a PLAM. This is, of course, not true with a conventional loan in which nominal interest must be paid on schedule. A project that is feasible in real terms is rendered infeasible under inflation by the forced annual retirement of the real loss of principal implicit in high nominal interest rates.

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The Impact of Recent Tax Legislation and Inflation on the Taxation of Farm Capital

Ron L. Durst and Ronald A. Jeremias

Abstract

This article analyzes the impacts of recent tax law changes and reductions in the rate of inflation on incentives for investment in farm capital. At present, effective tax rates on income from farm capital are well below those of 1980. The primary reasons for this decline are the drop in the rate of inflation and the statutory tax rate reductions contained in the Economic Recovery Tax Act of 1981 (ERTA). The changes in the capital cost recovery system contained in ERTA and the subsequent modifications of that system had only a slight impact on effective tax rate levels.

Key Words: Effective tax rate, ACRS, inflation, statutory tax rates, ADR, ERTA, TEFRA, capital cost recovery system.

During the latter part of the 1970s, inflation combined with the progressive federal income tax structure to increase individual income tax burdens substantially. By 1980, the percentage of household income that was paid in federal income taxes was greater than at any other time in recent decades (U.S. Congress, 1981a). In that year, the average income tax rate for individuals with farm earnings was 20 percent, a sharp increase over the 1971 average of less than 14 percent (U.S. Department of the Treasury, 1971, 1980).

In 1981, Congress responded to this rising tax burden by enacting the Economic Recovery Tax Act (ERTA), the largest tax cut in history. Among the more significant changes in personal income and business tax laws included in the act were multiyear statutory tax rate reductions, an indexing provision for tax brackets and personal exemptions, and a new capital cost recovery system, the Accelerated Cost Recovery System. This substantial tax cut was followed by the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA), a measure to increase tax revenues. TEFRA scaled back several of the tax provisions enacted under ERTA, including various provisions of the Accelerated Cost Recovery System.

This paper evaluates the impact of these recent tax law changes and reductions in the rate of inflation on incentives for investment in farm capital. The first and second sections of this paper briefly describe the data and procedures used to generate the estimates discussed in the remaining sections. Our estimates of the individual and combined effects of tax law changes and inflation on incentives for investment in depreciable farm capital for the period 1980-1984 are presented in section

Ron L. Durst and Ronald A. Jeremias are economists with the National Economics Division, Economic Research Service, United States Department of Agriculture. The views expressed herein are solely those of the auhtors and do not necessarily represent those of ERS or USDA. The authors thank Charles Barnard, Ken Krause, Wendy Rome, Jerome Stam, Dave Torgerson, and AFR reviewers for their comments on earlier drafts of this article. The authors also acknowledge the contributions of Jim Hrubovcak on earlier research on this subject.

three. The final section summarizes the conclusions of our analysis.

Estimation Procedures

One method of summarizing the impact on investment incentives of changes in the capital cost recovery system, statutory tax rates, and the rate of inflation is by calculating effective income tax rates for farm capital. Effective tax rates measure the fraction of the gross rate of return on investment that accrues to the government. They can be compared with statutory tax rates to determine whether income from capital is being sheltered from taxes or taxed at rates higher than statutory rates due to the effects of inflation on the real values of depreciation deductions and tax credits.

Following Auerbach and Jorgenson, Hulten and Wykoff, and others (Gravelle; U.S. Congress, 1981b), we define the effective income tax rate to be the percentage difference between the before-tax and after-tax rates of return on capital. We let s be the real before-tax rate of return on capital, and r the real after-tax return. The effective tax rate is $e = (s-r)/s$. For each private dollar that is invested in capital, the government earns a return of $(s-r)$ in the form of tax collections. The effective tax rate is the government's return expressed as a fraction of the before-tax return.

We assume that profit-maximizing farm operators adjust the sizes of their stocks of the various types of farm capital until all types earn the same after-tax rate of return. We hold the return constant for all assets and all years. Using information concerning the economic characteristics of each asset, and the treatment of its income by the existing tax system, we estimate the gross income that each asset would be required to earn to provide its owner with the given after-tax return. We use this gross income to compute the asset's before-tax rate of return.

We assume that each new unit of capital is produced and sold at a real price of q. We let a_t be the units of capital service that are provided by a unit of capital in its t*th* year of service, with $a_1 = 1$, and $1 \le t \le n$, where n is the asset's economic life. Salvage value is assumed to be zero. We let c be the real gross income that is earned by each full unit of capital service, and we refer to c as the implicit rental price of capital. The rental price is the gross rental rate that would need to be charged by an investor earning the after-tax return r. Each unit of capital earns a gross income of c when new, and an income of ca_t in its t*th* year of service. The rental price c is a function of the price of capital (q), the after-tax rate of return (r), and the income tax system.

Our formula for the rental price of capital is

$$c = \frac{q}{\sum_{t=1}^{n} a_t(1+r)^{-t}} \cdot \frac{1 - \bar{k} - u(1-y\bar{k}) \sum_{t=1}^{m} z_t(1+r)^{-t}(1+i)^{-t}}{(1-u)} \qquad (1)$$

where u is the statutory tax rate; i is the rate of inflation; k and k are the statutory and effective rates of the investment tax credit, respectively, with $\bar{k} = k/[(1+r)(1+i)]$ to reflect our assumption that the credit is not claimed until one year after the asset is purchased; y is the percent of the tax credit that must be deducted from each asset's purchase price to obtain the tax depreciation base; z_t is the fraction of the depreciation base that is claimed as a tax deduction in the asset's t*th* year; and m is the tax life of the asset. A complete derivation of this formula is available from the authors upon request.

The before-tax rate of return is the real discount rate s that produces an equality between the purchase price of a unit of capital and the present discounted value of the real gross income that the unit will earn. It is the s that is a solution to the equation.

$$q = \sum_{t=1}^{n} ca_t(1+s)^{-t} \qquad (2)$$

We estimate c, the rental price of capital, and then we solve equation (2) for s by searching for the value that satisfies the equation. The before-tax and after-tax returns are then used to compute the effective income tax rate.

Assumptions

The capital stock of the farm sector is composed of many different types of farm equipment and structures. Many of these capital assets, however, have similar economic and tax characteristics. Thus, to simplify the estimation task, all depreciable farm equipment and structures were divided into five categories: motor vehicles, farm

machinery, crop storage structures, unitary livestock structures, and multipurpose structures. The economic and tax characteristics of the assets within each category were assumed to be identical. Thus, only five separate series of estimates of effective tax rates were used to represent all farm equipment and structures.

The average economic lives of the assets in each category were determined by using averages of Bulletin F depreciation lives (U.S. Department of the Treasury, 1942). These economic lives are: motor vehicles, 6 years; farm machinery, 15 years; crop storage structures, 25 years; and unitary livestock structures and multipurpose structures, 50 years.

All assets were assumed to exhibit the same concave pattern of decline in service capacity:

$$a_t = 1 - [(t - 1)/n]^2 \qquad (3)$$

where t is the age of the asset, a_t is the amount of service capacity remaining at age t, and n is the asset's economic life.

Our estimates of effective tax rates apply to marginal (additional) investments and are therefore functions of the highest statutory rate at which an investor's income is taxed. Larger incomes are generally taxed at higher rates. We computed separate estimates of effective tax rates for investors having taxable incomes of $15,000 and $60,000 in 1980. Taxable incomes for 1981-1984 were adjusted to maintain the same real income over the five-year period. The adjusted income levels and corresponding marginal statutory tax rates are presented in table 1. These rates reflect the statutory tax rate reductions contained in ERTA.

Table 1. Taxable Incomes and Marginal Tax Rates, 1980-1984

	Low-income investor		High-income investor	
Year	Taxable income	Marginal tax rate	Taxable income	Marginal tax rate
	Dollars	Percent	Dollars	Percent
1980	$15,000	21	$60,000	54
1981	$16,556	24	$66,224	50
1982	$17,571	22	$70,284	49
1983	$18,221	19	$72,885	44
1984	$18,913	18	$75,655	42

Permissible methods for computing tax depreciation deductions have varied over time and by asset. We employed those methods that maximized the real present values of tax depreciation deductions and thus minimized effective tax rates. Under the old Asset Depreciation Range System (ADR) effective in 1980, the present values of tax depreciation deductions for motor vehicles, farm machinery, and crop storage structures were maximized by using the sum-of-the-years' digits method (with additional first-year depreciation of 20 percent) and the minimum permissible tax lives of six, eight, and eight years, respectively. The present values of deductions for other farm structures were maximized by using the 150 percent declining-balance method and a tax life of 20 years. Beginning in 1981, the present values for all assets were maximized by using the new tax depreciation schedules and minimum tax lives contained in ERTA. The new minimum tax lives are three years for motor vehicles, five years for farm machinery, crop storage structures, and unitary livestock structures, and 15 years for multipurpose structures.

Since tax depreciation deductions and credits are based on the historical cost of assets, their real values are reduced by inflation. Our estimates of effective tax rates were computed using inflation rates of 12.4 percent in 1980, 8.9 percent in 1981, 3.9 percent in 1982, and 3.8 percent in 1983. These rates are based on December-to-December changes in the nsumer Price Index. We assumed that the 1984 inflation rate would be six percent.

In addition to tax depreciation deductions, all types of farm equipment and structures except multipurpose structures are eligible for the investment tax credit. In 1980, the credit equalled ten percent of the purchase price for farm machinery, crop storage structures, and unitary livestock structures, and 6.7 percent for motor vehicles. Beginning in 1981, the credit for motor vehicles was reduced to six percent. The rate for other eligible types of farm machinery, equipment, and structures remained at ten percent.

For 1983 and beyond, the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) required that investors reduce all tax credits by two percent or reduce an asset's tax depreciation base by half of the amount of the tax credit claimed. Since the latter option

generally yielded the lowest effective tax rates. we elected to reduce the tax depreciation base.

Beginning in 1982, investors could expense (immediately deduct) the cost of a limited amount of investment. However, no investment tax credit is permitted on expensed property. Since expensing generally yielded effective tax rates that exceeded those which could be obtained by claiming permissible tax depreciation deductions and credits, the expensing option was not utilized in this analysis.

All assets were assumed to have been purchased with full equity financing. The real after-tax rate of return on equity was assumed to be constant at six percent for all assets and all investors. To earn the same after-tax return, investors in the higher tax brackets would need to earn a larger before-tax return than those in the lower tax brackets. There is some evidence that larger farms earn higher before-tax returns on farm capital, presumably as a result of economies of scale (Hottel and Reinsel). Nevertheless, we found that variations in the assumed after-tax rate of return within the range of five to ten percent had only a slight impact on estimates of effective tax rates.

Results

Our estimates of average effective tax rates for 1980-1984 are presented in table 2. There are some wide differences in tax rates for the various types of farm capital. These differences may be affecting the farm capital mix (Jeremias, Hrubovcak and Durst). Since 1982, there has been a slight upward trend in the average tax rates for all farm capital, but tax rates for 1984 remain well below those of 1980.

Most of the effective tax rates in table 2 are less than the corresponding statutory tax rates shown in table 1. Some of the rates are actually negative. The negative tax rates indicate that the government is subsidizing many of the investments of low-income investors in farm capital.

The variation in effective tax rates over the 1980-1984 period can be attributed to the combined effects of three factors: changes in the rate of inflation, reductions in statutory tax rates, and modifications of the capital cost recovery system. Since the relative importance of these factors cannot be determined from the effective tax rates presented in table 2, the following sections isolate the impact of each of these factors on effective tax rate levels.

Capital Cost Recovery System

The capital cost recovery system specifies the rate and time period over which depreciation deductions may be claimed. Since depreciation deductions are limited to the historical cost of assets, inflation reduces the real values of the deductions that are claimed in the years following the year of purchase. These lower

Table 2. Effective Income Tax Rates for Farm Capital, 1980-1984

Asset type	1980	1981	1982	1983	1984
	Investor with $15,000 taxable income				
Motor vehicles[a]	.06	.08	−.13	−.14	−.09
Farm machinery[b]	−.04	−.01	−.17	−.17	−.13
Crop storage structures[c]	−.03	−.01	−.11	−.11	−.09
Unitary livestock structures[d]	.10	−.01	−.07	−.07	−.06
Multipurpose structures[e]	.21	.20	.15	.13	.14
All capital (average tax rate)[f]	.02	.03	−.10	−.10	−.07
	Investor with $60,000 taxable income				
Motor vehicles[a]	.59	.52	.30	.28	.33
Farm machinery[b]	.42	.39	.17	.17	.21
Crop storage structures[c]	.33	.31	.12	.12	.16
Unitary livestock structures[d]	.47	.23	.09	.08	.11
Multipurpose structures[e]	.53	.47	.38	.33	.34
All capital (average tax rate)[f]	.45	.35	.20	.19	.22

[a]Autos and trucks.

[b]Tractors, combines, and all other farm machinery except motor vehicles.

[c]Silos, corn cribs, grain storage bins, and all other structures used principally for the bulk storage of crops.

[d]Milking parlors, poultry houses, unitary hog-raising facilities, and other structures used for the housing, raising, and feeding of a single type of livestock.

[e]Barns, machine sheds, garages, warehouses, dwellings for hired farm labor, structures used for the housing, raising, or feeding of more than one type of livestock, and all structures not classified elsewhere.

[f]Average effective tax rates were calculated by comparing the assumed six percent after-tax return with the weighted average of the before-tax rates of return on the five types of farm capital, with the weights proportional to the total market value of each type of capital.

real values produce higher effective tax rates. Thus, the timing of tax depreciation deductions is an important determinant of effective tax rates for capital income.

The capital cost recovery system used from 1971 to 1980 was the Asset Depreciaton Range System (ADR). This system was replaced by the Accelerated Capital Cost Recovery System (ACRS) in 1981. For most farm assets, the tax depreciation deductions under ACRS were initially not as generous as those permitted by ADR. However, ERTA provided that the ACRS deductions would be accelerated in 1985 and again in 1986. TEFRA cancelled the phase-in of the more generous deductions and reduced the value of investment tax credits.

Table 3 provides a comparison of average effective tax rates under ADR and ACRS. All of the tax rates in table 3 were computed using the 1980 inflation rate of 12.4 percent and the applicable statutory tax rates of 21 percent for low-income investors and 54 percent for high-income investors. These results suggest that ACRS, in its fully phased-in form, would have produced average effective tax rates below those existing under the ADR system. However, this difference would have been relatively small. This is consistent with Gravelle who found that the tax reductions for the agricultural sector were not as substantial as those for other sectors.

If the 1980 inflation rate and statutory tax rates had remained unchanged, the modification of ACRS by TEFRA would have increased average effective tax rates above those existing under ADR. Thus, despite the fact that incentives for investment in capital used in other sectors may be greater under the current system than under the ADR system, incentives for investment in depreciable farm capital are actually less than under the ADR system.

Table 3. Effective Tax Rates Under Alternative Capital Cost Recovery Systems, 1980[a]

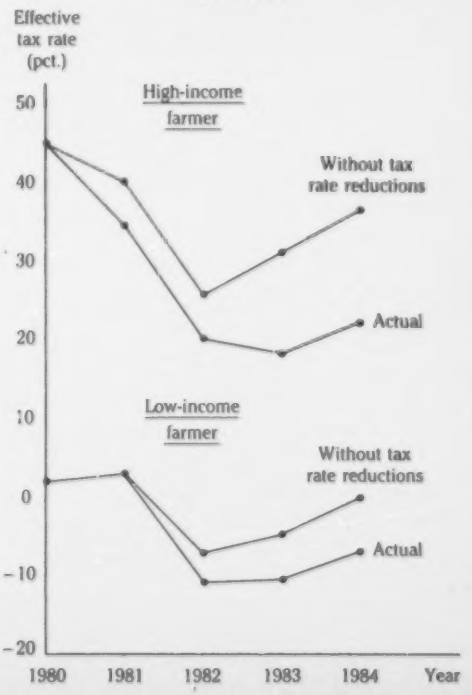
Taxable Income	ADR	ACRS		
		ERTA		TEFRA
		Initial	Full Phase-In	
Dollars	Percent			
15,000	2	4	0	6
60,000	45	46	42	48

[a]Figures shown are weighted averages of marginal effective income tax rates for the five types of farm capital shown in table 2. Weights are proportional to the values of the 1980 stocks of each type of capital. Estimates of effective tax rates were computed using the inflation and statutory tax rates for the 1980 tax year.

Statutory Tax Rate Reductions

Statutory tax rates and effective tax rates are equal only to the extent that taxable income equals the true income actually earned by the investor. Nevertheless, an increase or decrease in the statutory rate produces an increase or decrease in the effective rate. Figure 1 compares our estimates of effective tax rates for the period 1980-1984 with those that would have existed without the 23 percent reduction in statutory tax rates included in ERTA. The statutory tax rate reductions contributed to lower average effective tax rates for both low-income and high-income investors. This year (1984), the average tax rate for low-income investors is seven percentage points below what it would have been without the statutory tax rate reductions. The difference for high-

Figure 1. Comparison of Effective Tax Rates With and Without ERTA Tax Rate Reductions, 1980-1984

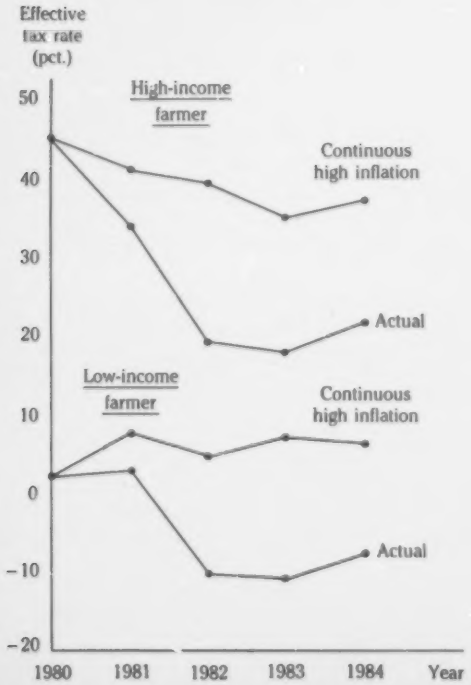


income investors is even more substantial. The average tax rate for these investors is now 22 percent. This is 17 percentage points below what it would have been without the tax rate reductions. One reason for this sharp drop in the effective tax rate for high-income investors was the reduction in the top statutory tax rate from 70 percent to 50 percent for 1981 and later years.

Inflation

Inflation affects the tax burden on income from capital in two ways. First, it raises nominal incomes causing a gradual increase in marginal statutory tax rates or tax brackets. This is often referred to as bracket creep. Second, it reduces the real values of the tax depreciation deductions and credits which must be claimed in future years. Figure 2 illustrates the relative importance of the reduction in the inflation rate. It compares the actual average effective tax rates for the period 1980-1984 with those that would have occurred if inflation had continued at the 1980 rate of 12.4 percent. For high-income investors, the sharp drop in the rate of inflation reduced the average effective tax rate for 1984 from 38 percent to 22 percent. Although the actual percentage point reduction in effective tax rate for low-income investors was slightly lower, the relative impact was much greater. Without the reduction in inflation, the average effective tax rate in 1984 would have been seven percent rather than minus seven percent. The main factor contributing to this larger relative change for low-income investors is the differential impact of bracket creep on low-income and high-income investors. High-income investors with statutory tax rates near the top statutory rate of 50 percent are rarely affected by bracket creep. Thus, reductions in the rate of inflation and the indexing of the tax brackets and exemption levels scheduled to begin in 1985 will provide relatively greater benefits to lower-income investors.

Figure 2. Impact of Inflation on Effective Tax Rates, 1980-1984



Conclusions

Our results suggest that average effective income tax rates for farm capital have declined since 1980, primarily as a result of the sharp reduction in the rate of inflation. The marginal tax rate reductions contained in ERTA, which were more than sufficient to offset the effects of bracket creep on statutory tax rate levels, also contributed to slightly lower effective tax rates. In contrast, the introduction of ACRS and the subsequent modifications of that system by TEFRA actually reduced incentives for investment in farm capital. Thus, despite the substantial amount of tax legislation that has been enacted since 1980, our findings indicate that in the absence of a decline in the rate of inflation, average effective tax rates for low-income investors would have increased from 1980 to 1984. In addition, reductions in average effective tax rates for high-income investors would have been relatively minor.

Beginning in 1985, the effects of inflation on effective tax rates will be somewhat lessened by the indexation of tax rate schedules and exemption amounts. While this will eliminate bracket creep, inflation will continue to affect the real values of nominal tax depreciation deductions and tax credits. Therefore, in the absence of major tax reform, inflation will continue to be the dominant factor affecting the effective income tax rates for farm capital. If the rate of inflation continues at its current pace or declines, average effective income tax

rates will remain well below those of 1980. Under current law, double-digit inflation would have to occur to raise effective tax rates to their 1980 levels. Thus, barring a sharp rise in the rate of inflation or a delay in the indexation of tax brackets and exemption amounts, the existing capital cost recovery system will continue to provide substantial incentives for investment in depreciable farm capital.

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Banks and Farm Credit as Agricultural Lenders in Indiana

David A. Sherman and Lee F. Schrader

Abstract

Lender performances of commercial banks and the Farm Credit System (FCS) are compared using data from a survey completed during 1981. The survey was undertaken during a period of highly variable interest rates and changes in lending practices. FCS lenders were making loans at lower interest rates and with nominally more liberal credit terms than banks. FCS lenders, unlimited by state branching law, served larger areas than banks. Operating costs relative to loan volume were lower for the FCS lenders. Interest rate spreads were lower for banks at the time of the survey.

Key words: agricultural credit, cooperative credit interest rates, costs, lender performance.

The use of credit to finance agriculture has increased dramatically in the past decade. Total farm debt increased from $53 billion at the beginning of 1970 to $216 billion, January 1, 1983. As a result, the availability and terms of credit have become more important determinants of the structure, profitability, and financial stability of the agricultural economy. Commercial banks and the FCS are the most important institutional sources of credit to farmers. These lenders accounted for 49.6 percent of farm real estate debt and 56.2 percent of farm nonreal estate debt as of January 1, 1982. (Duncan, p.4)

Production Credit Associations (PCAs) and Federal Land Bank Associations (FLBAs), parts of the FCS, are cooperatives owned by and operated for the benefit of their borrower patrons. Commercial banks are usually operated for the benefit of their owners who, only incidentally, may also be patrons. Commercial banks have been subject to pervasive regulation including lending limits and regulation of interest rates paid on deposits. Indiana law limits branch banking to within the county in which the main bank is located, but does not restrict the size of the area served by units of the FCS. These differences might be expected to affect the performance of these institutions as lenders. For example, FCS lenders were expected to be oriented more to needs of their farmer-owners and, bank performance was expected to favor the private owners of the commercial banks.

The objective of our study was to compare the performance of banks to the performance of the Farm Credit System (PCAs and FLBAs) in Indiana with respect to farmer-borrowers and financial performance of the institutions themselves. We identify performance measures related to each of these groups and report the results of a survey of lending institutions conducted during the spring of 1981.

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A number of studies of bank performance have been based on the industrial organization paradigm. Heggestad described and analyzed more than 40 studies of bank performance and market structure. A Chicago Federal Reserve Bank study cited by Heggestad concluded that farm loan interest rates at banks were lower when a PCA was operating in the same market. Performance measures used in the studies reviewed include interest rates charged, number of banks, number of offices, profitability, and portfolio selection. None of the studies in his review compared the performance of banks and the FCS.

Webb investigated the allegation that advantages in regulation available only to PCAs have resulted in diminished commercial bank performance. He concluded that—based on an analysis of the affect of major regulatory and insitutional differences on bank profitability and market share—the differences in regulation had not been economically harmful to commercial banks as a whole.

Lender Performance

Performance dimensions affecting farmers as borrowers include interest rates, loan covenants, loan size, and recent changes in loan terms. Factors affecting the institution (its owners) were identified as return on assets, return on equity, effective tax rate, expenses relative to loan volume, interest spread, and loans outstanding relative to total assets. The financial health of farm borrowers, related to lender performance, is important to both borrowers and institution owners.

The share of farm real estate lending by FLBAs increased dramatically during the 1970s at the expense of all lender groups except Farmers Home Administration (FmHA). PCAs' share of nonreal estate lending increased slightly during the same period while banks lost share, primarily to FmHA. These data indicate a major differential in attractiveness of lenders to farmer-borrowers.

Procedure

Data were collected directly from financial institutions. Separate but roughly parallel survey forms were used for banks, PCAs, and FLBAs. The bank questionnaire was administered in personal interviews with a bank executive or an agricultural loan officer. The FCS organizations were interviewed by mail because we had reason to expect complete cooperation from these organizations.

Annual reports for calendar year 1980 were requested for all survey respondents. Information in these somewhat variable documents was supplemented by Bank Call and Income reports which were obtained from regulatory agencies. Detailed financial statements for Indiana PCAs were obtained from the Federal Intermediate Credit Bank of Louisville and for the FLBAs either directly from the institution or from the Federal Land Bank of Louisville.

All Indiana PCAs (10) and FLBAs (23), cooperated in the survey. Approximately 230 of the 411 commerical banks in the state had at least a $2.5 million loan commitment to agriculture or had 25 percent or more of their loan portfolio in farm loans (our definition of an agricultural bank). All banks in each of the ten PCA areas were listed in random order. Banks, contacted in order from the random list, were selected for inclusion in the sample if the bank qualified as an agricultural bank and if it agreed to participate in the survey. The process was continued in each area until 20 percent of the banks in that area were included. Thus, the 80 bank sample which was selected included about 20 percent of all banks distributed geographically in proportion to all banks but including only those classed as agricultural.

The data for FCS lenders represented the population. Therefore, statistical tests were structured to test for differences between banks and the known population values for the FCS lenders.

Results

A summary comparison of banks and FCS lenders with respect to interest rates, loan terms, maximum loan as a percent of collateral, and average loan size is presented as table 1. Interest rates charged for long-, intermediate- and short-term loans as of March 31, 1981, were collected. Direct comparison was possible only for variable rate loans because PCAs and FLBAs wrote no fixed rate loans. Banks were in a period of adjusting their philosophy of loan pricing during this period of high and volatile interest rates. Many had not converted to variable interest rates

and were unwilling to make any long- or intermediate-term loan commitments.

Rates of interest charged by FCS lenders (adjusted to include mandatory stock purchase) were 2.8 to 4.8 percentage points lower than comparable bank rates in March 1981. This rather substantial difference reflects the use of average cost of funds as a rate base for PCAs and FLBAs rather than current cost used by banks in a period of rising interest rates. The same procedure would produce lower rates for banks in a period of declining interest rates. Bank rates for fixed rate loans were slightly lower than for variable rate loans at the time of inquiry.

Table 1. Agricultural Loan Characteristics by Type of Loan and Type of Lender

Loan Characteristics	Banks	PCA's	FLBA's
Interest rates charged		*percent*	
Long-term			
fixed rate	15.72		
variable rate*	16.48		11.68[a]
Intermediate-term			
fixed rate	17.44		
variable rate*	17.77	14.95[a]	
Short-term			
fixed rate	17.37		
variable rate*	17.75	14.95[a]	
Average loan maturity		*years*	
Long-term			
fixed rate	14.03		
variable rate*	12.58		28
Intermediate-term			
fixed rate	3.00		
variable rate	4.14	4.07	
Short-term			
fixed rate	.54		
variable rate*	.73	1.00	
Loan limit as percent of collateral			
Long-term			
fixed rate	76.05		
variable rate*	77.67		84.13
Intermediate-term			
fixed rate	75.52		
variable rate (NT)	74.17	80-100	
Short-term			
fixed rate	75.33		
variable rate (NT)	74.33	80-100	
*Number of farm borrowers**	218	2094	905
Average loan size (NT)	$54,316	$43,457	$68,050 NT

*Difference between banks and FCS lender significant at .05 level.

NT= Not tested

[a]Adjusted for mandatory stock requirement

The average maturity of long-term (real estate) loans by FLBAs was 28 years, more than twice that for banks. Some of the banks were reluctant to write long-term loans, but, instead, used guaranteed renewable short-term loans to finance real estate. Thus, the effective difference may be less than it appears to be. The length of variable rate intermediate-term loans at banks which did make these loans did not differ significantly from those at PCAs. Banks made short-term loans for the specific period needed by the borrower, whereas PCAs made loans for one year as a standard practice. Lines of credit were not treated separately in the survey.

The mean maximum agricultural loan by FLBAs was 84 percent of collateral, significantly higher than that of banks. Respondents found it difficult to characterize short-term loan maxima as a percent of collateral because many granted unsecured loans or based their decision on the applicant and the project. The FCS lenders did indicate a higher maximum loan relative to collateral for all loan types than did bankers who provided maximum loan data.

Areas served by PCAs and FLBAs were larger than banks which were limited by branching laws. Thus the average number of farm borrowers per unit and the average number of agricultural loans outstanding for the FCS lenders far exceeded those for banks. The average individual loans were largest at FLBAs ($68,050) followed by banks at $54,316 and PCAs at $43,457. The loan size differences reflect different mixes of loan types and may not indicate any difference in size for similar loan types. Banks were unable to provide data by type of loan.

Lenders were asked if their use of 18 loan terms other than interest had changed from spring 1980 to summer 1981 (table 2). Significant differences in the pattern of changes in or use of loan terms between banks and FCS lenders were evident in most cases. Banks indicated somewhat more changes as all three lenders moved toward greater loan security

Table 2. Percent of Lenders Increasing and Decreasing* the Use of Selected Loan Terms from Spring 1980 to Summer 1981 by Type of Lender.

Loan terms	Banks		PCAs		FLBAs		
	Inc	Dec	Inc	Dec	Inc	Dec	
Amount of collateral required	53.7	0	20.0	0	28.6	0	**
Use of variable rate loans	61.2	0	20.0	0	42.9	0	**
Length of loan	22.5	46.2	20.0	20.0	0	9.5	**
Line of credit financing	55.7	0	20.0	0	31.6	0	**
Partially amortized loans	30.0	5.0	10.0	0	20.0	0	**
Short term automatic renewal	32.9	6.3	20.0	0	19.0	0	**
Prohibit equipment purchase	21.2	1.2	50.0	0	9.5	0	**
Prohibit dividend payment	2.5	0	0	0	4.8	0	**
Require management input	33.7	0	55.6	0	42.9	0	**
Require more farmer equity	37.5	0	40.0	0	47.6	0	
Limit amount for family living	13.7	0	10.0	0	14.3	0	
Subordinate other debts	21.2	1.2	22.2	0	14.3	0	**
Require cash budgets	61.2	0	90.0	0	57.1	0	**
Require periodic financial statements	37.5	0	80.0	0	38.1	0	**
Require farmer to become current with accounts payable	30.0	0	30.0	0	33.3	0	**
Require second mortgage as security	68.8	0	30.0	0	38.1	0	**
Require personal guarantee	47.5	1.2	30.0	0	20.0	0	**
Require all banking or financing at same institution	47.0	0	10.0	10.0	10.0	0	**

*Remaining respondents reported no change or did not use the loan term.

**Banks significantly different from one or both PCAs and FLBAs at the .05 level using Chi-square test.

and attention to or control over the borrower's business. The largest number of banks indicated increased collateral requirement, variable rate loans, line of credit financing, required cash budgets, and use of second mortgages. The FCS lenders had already switched to variable rate loans. Their indication of change toward variable rates could reflect only the maturation of older loans. The pattern of changes in FCS lender terms was primarily toward greater knowledge and monitoring of the borrower's business.

Questions regarding reasons for loan denials revealed that loan limits and lack of funds limited bank lending but did not limit FCS lenders. Insufficient collateral was cited by banks substantially more often than by FCS lenders. Excessive operating risk was cited most often by all three types of lenders but appeared to be a much more important reason for loan denials by FCS lenders than by banks.

Financial performance and costs of operation were calculated for selected measures (table 3). Some measures could not be calculated for individual FLBAs because FLBAs are organized as agents or branches of the Federal Land Bank of Louisville. In those cases data represent the entire Louisville district. Return on assets was found to be highest for PCAs, with banks reporting the highest return on equity. This reflects the PCAs relatively conservative balance sheet. The FLBs and PCAs, having no reserve requirement, are able to maintain higher loan to total assets ratios than banks, averaging 88.5 percent and 97.2 percent respectively, contrasted with 55.1 percent for banks. Costs measured were generally lower for the FCS lenders except for FLBA office space. The measures selected do not take into account the additional services provided by banks nor the difference in sources of loanable funds. Interest expense as a percent of loans outstanding was lowest for the FLB (8.018) and highest for PCAs (10.74) at the time of the survey. The interest spread, calculated as interest income less interest expense as a percent of assets, was largest for PCAs (1.79) and lowest for the FLB (0.742). The lower than expected interest spread for banks (.964) is due partly to the use of bank assets to generate income other than interest. It also reflects the relatively low loan to assets ratio of banks and a substantial amount in lower fixed interest rate loans outstanding in a period of high interest rates. Thus, the result reflects the differential impact of the financial

environment which may outweigh any institutional difference at the time of the survey.

A higher effective income tax rate for PCAs relative to banks reflects the fact that banks can take advantage of certain tax free investments which are not used by PCAs. The Federal Land Banks are not subject to federal income tax.

Respondents were asked about trends in overall demand for farm loans they perceived during 1980. All but five of the FLBAs found that the demand for long-term loans was increasing whereas only a third of the banks indicated such an increase. About a third of the banks and 40 percent of the PCAs perceived an increase in demand for intermediate-term loans whereas 60 percent of the banks and 90 percent of the PCAs saw an increase in demand for short-term loans. When asked about change in their own agricultural loan volume, more than half of the banks, 70 percent of the PCAs, and all but one FLBA indicated an increase in volume.

Table 3. Performance of Banks, PCAs, and FLBAs on Selected Financial and Operation Measures

Measure	Banks	PCAs	FLBAs
		Percent	
Net income, percent of assets	1.041	1.300	0.750[a]
Net income, percent of equity	12.408	8.205	8.413[a]
Loans, percent of assets	55.092	88.520	97.220[a]
Salaries & benefits, percent of loans	2.435	.840	0.170
Cost of space, percent of loans	0.166	0.073	0.222
Interest expense, percent of loans	10.224	10.740	8.018[a]
Interest spread, percent of assets	0.964	1.790	.742[a]
Effective federal income tax rate	14.797	42.820	NA

[a]Calculated for Federal Land Bank of Louisville.

Table 4. Percent of Farm Loans in Various Conditions in 1980 by Lender Type.

Status of loan	Banks	PCAs	FLBAs
		Percent	
Easily paid debt	63.2	44.0	76.3
Difficulty paying debt	26.1	31.9	17.6
Did not pay, still farming	9.2	22.5	4.2
Did not pay, quit farming	1.5	1.6	1.9

The financial condition of borrowers in 1980 (reported by lenders) varied with type of lender (table 4). The percentage of borrowers who did not repay debt and left farming was larger for the FCS lenders but the differences were not statistically significant. The proportion not paying debt but still farming was highest for PCAs and lowest for FLBAs. The data indicate that PCA borrowers were in poorer financial condition than bank and FLBA borrowers. This may reflect the concentration by the PCAs on operating credit in a year of poor crop yields.

Conclusions

To interpret the results of this study one must recognize that the survey covers a period of rapid change in interest rates and regulation of banks. Lenders and borrowers alike were adjusting to change. The data represent the situation in 1980 and early 1981, which cannot be characterized as an equilbrium state of the relationship among lenders.

FCS lenders were making loans at lower interest rates and with more liberal terms than banks. FCS lenders were also generally willing to make loans for a larger percentage of collateral than banks. Larger numbers of borrowers were served by individual FCS associations than by banks, which are limited by Indiana law to within-county branching.

Operating costs relative to loan volume for the FCS lenders were lower than for banks. Some or all of that difference may be due to differences in noncredit services offered or to costs of serving depositors for banks. Interest spreads were lowest for FLBAs and effective income tax rates were found to be higher for PCAs than for banks. No consistent differences in financial health of borrowers were identified among the lender types.

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Equity Levels Necessary for Successful Entry Into Dairy Production

William Grisley and Matthew C. Grady

Abstract

The minimum level of equity necessary to successfully enter dairy production on a family farm with 1.5 person units of labor is investigated under different types of business organizations, milk production levels, sources of financing, and rental rates on cropland and milking facilities. Results indicate that under the most favorable circumstances an owner-operator would need $71,579, a whole-farm renter would need $20,824, and a milking-facility renter would need $37,604 in starting equity to be financially solvent at the end of a five-year period. The whole-farm and milking-facility rental business organizations offer the most viable opportunities for success.

Key words: dairy production, successful entry, beginning equity, financial solvency.

The structure of the dairy industry in the Northeast is characterized by the family owner-operated production unit. Family farms supply most of their own labor requirements, produce a majority of their feed inputs, and raise their own replacement heifers. The future survivability of the family-operated dairy farm depends upon the continued successful entry by young farm families and its comparative advantage in feed and milk production (Malone). Difficulty of entry is directly related to the initial level of equity funds held by beginning farmers, their access to debt funds at reasonable rates and terms, and the general profitability of milk production. The accumulation of a sizable amount of equity funds is of critical importance. Few lending institutions are willing to lend funds to a beginning farmer who has little or no equity because of the risk involved in meeting large debt repayments.

Beginning farmers have typically gained access to equity funds through inheritance, marriage, or accumulation from employment earnings. Regardless of the amount of equity funds a prospective entrant has available, questions regarding the future profitability of milk production must be considered when investigating the financial feasibility of entry and progress over time. The persistent and increasing excess supply of dairy products will have important implications regarding the milk price support program and dairy farm profitability in the future.

The purpose of this study is to investigate the minimum level of equity necessary for a young farm family to successfully enter dairy production and be financially solvent at the end of a five-year period. To make the analysis as broad as possible, three different types of

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family farm organizations common in Pennsylvania and the Northeast are examined. These are the owner-operated, whole-farm rental, and building-facility rental business organizations. Each is analyzed under various assumptions on milk production per cow, debt financing terms, and farm rental rates. The farm operations are simulated over a five-year period to determine the minimum starting level of equity funds necessary to achieve financial solvency. A farm alternative is deemed to be financially solvent if it is able to pay all cash expenses, debt payments, and income and social security taxes by the end of the fifth year and withdraw $12,000 annually for family living expenses. The dollar value of starting equity necessary to meet the financial solvency criterion was used as the indicator of ease of entry into dairy production.

This paper is organized into four sections. Previous efforts that examined issues of entry are reviewed in section one. The model assumptions and data used are presented in section two. The simulated results are summarized in section three, and the implications for entry are discussed in section four.

Literature Review

Over the past decade there has been a renewed concern about the farm entry problem. Most of the published studies examined issues relating to the difficulty of entry at various points in time, financing schemes for the low-equity farmer, land shortages, and the importance of the father-son relationship. Investigating agricultural production in two counties in New York and one county in Minnesota, Lowenberg-DeBoer found little difference in the degree of difficulty for successful entry for the years 1910, 1930, 1950, and 1978. His conclusions for young tenants, however, indicated that problems associated with equity capital accumulation have increased over time and without new entrants the existence of the family farm could be severely threatened. These findings agreed with those of LaDue who found that, in general, it was at least as difficult to enter agricultural production in 1979 as it was during the 1950s for entrants using institutional type financing and leasing arrangements.

Successful entry strategies followed by beginning farmers include the "agricultural ladder" process, the father-son relationship, and "marrying it." In the "agricultural ladder" process the entrant starts as a farm worker and accumulates enough capital to become a renter, then a partial owner, and finally a full owner (Boehlje, 1973). Today, few argue that the "agricultural ladder" is a viable strategy because the amount of capital necessary to get started on an economically viable unit is beyond the capacity of most potential young entrants. The father-son relationship was found by Brake to be a viable alternative for new entrants. Family assistance was also found to be important for success by Boehlje and Thomas, Epperson and Bell, and Reiss. Creative financing schemes were investigated by Baker McClateky, Boehlje (1981), and Penson and Duncan. However, Kanel concluded as early as 1960 that attempts to assist potential entrants through the use of increased credit availability would only increase the demand for farm opportunities and have no affect on the supply.

The amount of beginning equity and the level of debt-to-assets for successful entry has been investigated by several writers. Herr and Obrecht found a Midwestern farmer could successfully enter with only one-quarter of the average investment of an established farm if land and capital equipment were rented rather than debt financed. Investigating low equity positions and debt terms, Harris and Saupe found that while low equity was not a problem itself, high levels of short-term debt could result in severe cash flow problems. Hanson and Thompson found that small and medium size dairy farms could be successful with debt-to-asset ratios of 0.348 and 0.414, respectively.

Simulation Model Assumptions

A firm level simulation model originally developed by Hutton and Hinman was modified and used to analyze the different farm alternatives over a five-year period. The five-year period was selected because it allows for debt refinancing in the early years of the operation if cash flow problems emerge. Lending institutions frequently permit refinancing during the first few years, but may be reluctant to continue a refinancing program if the farm is not successful after a period of five years.

The owner-operator (O-O), whole-farm renter (F-R), and building-facility renter (B-R) farm types were analyzed by level of milk production, source of financing, and rental rate. A total of 42 distinct farm alternatives were analyzed. The O-O farm is a fully owned production unit that purchases all assets with debt or equity funds and produces feed, replacement heifers, and milk. The F-R farm is identical to the O-O farm with the exception that all real estate is rented on a cash basis. The B-R farm cash rents the milking facility and purchases all feeds. The O-O and F-R farms were assumed to milk 40 cows and hold 29 heifers of various ages in each of the five years. This relation of heifers-to-cows is similar to the average on dairy farms in Pennsylvania. The B-R farm was assumed to milk 50 cows and have 36 replacement heifers of various ages. A larger livestock inventory was assumed for this farm because all feeds are purchased, thus freeing labor for milking additional cows. Equilibrium in cow numbers on all farms was maintained over the five-year period through the use of 28 percent culling rate for the milking herd, a 13.55 percent culling rate for heifers, a calving rate of 90 percent, and a death-loss rate of 2 percent for cows and 2.5 percent for heifers. All bull calves were sold within three days of birth.

The O-O and F-R farms were assumed to have 76 acres of forage crops, 42 acres of corn grain, and a stanchion barn with adequate heifer and feed storage space. The B-R farm has a stanchion barn and feed storage facilities to store purchased feeds. Crop production and land management ability on the O-O and F-R farms were assumed to be average or below. Actual crop yields and prices used were taken from the 1981 Pennsylvania Farmers Association (PFA) records for farms of similar size.[1] Corn grain yields were 74.27 bushels per acre, alfalfa yields were 2 tons per acre, and corn silage yields were 14.02 tons per acre. The O-O and F-R farms were assumed to produce their corn silage requirements, but were allowed to produce corn grain and hay in excess of the herd's requirements. All marketed feeds over the five-year period were sold at 1981 average farm-gate prices with alfalfa at $99 per ton and corn grain at $2.60 per bushel. The B-R farm purchased alfalfa and corn grain at these prices and purchased corn silage at $22.60 per ton. Pasture was not included as all livestock were assumed to be confined to the barn and a small exercise lot. Feeding requirements for concentrates, hay, and corn silage were taken from *The Penn State Farm Management Handbook*.

The machinery and equipment package used in crop production was assumed to be composed of second-hand items and adequate to handle the acreage cropped over the five-year period without major repairs or replacement. A machinery maintenance expense of $3,396 per year was included in the operating expenses for the O-O and F-R farms. No crop machinery and equipment were included in the B-R farm analysis. Each of the farm types employed 1.5 person equivalents of labor, with the operator contributing one unit, the spouse contributing 0.25 units, and 0.25 units of hired labor for periods of peak demand and at times of operator illness or absence from the farm. Even though the B-R farm does not produce feed, hired labor will be required for feed storing. Hired labor was budgeted at $4 per hour. When applicable, real estate taxes were levied at a rate of 1.5 percent of the value of land and buildings. Insurance expenses on buildings were estimated using a rate of $0.012 per dollar of inventory and insurance on machinery and livestock was expensed at $0.0066 per dollar of inventory. Family living withdrawals were held constant at $12,000 per year for all farms over the five-year period. In the base year, 1981, milk was sold at $13.50 per hundred pounds, cull heifers were sold at $600 each, culls cows were sold at $41.08 per hundredweight, and bull calves were sold at $86.40 per hundredweight. These values are in agreement with 1981 PFA record figures.

The farm types were analyzed using three levels of milk production per cow (13,000, 15,000, and 17,000 pounds), two sources of debt financing—Farmers Home Administration (FmHA) and the Farm Credit System (FCS)—and three rental rates for cropland and buildings. Three levels of milk production were selected to represent farms of average to excellent dairy management and cow technology. As a comparison, Pennsylvania and PFA averages for 1981 were 12,434 and 13,594 pounds per cow. Under FmHA financing, real estate mortgage terms were 35 years at a 10.75 percent annual rate of

[1]The Pennsylvania Farmers Association collects records for more than 2,000 Pennsylvania dairy farmers.

interest. Farm Credit System real estate loans were for 35 years at a 15.5 percent rate of interest. Intermediate-term debt for financing machinery and equipment and livestock was set up on a seven-year repayment schedule at an interest rate of 10.25 percent for FmHA funds and 15 percent for FCS funds. Operating debt maturity was set at two years with interest rates of 10.25 percent for FmHA and 15 percent for FCS.[2] The debt structure in the base year for the O-O farm was 60 percent in real estate and 40 percent for intermediate and operating debt. For the latter, 90 percent was assumed to be intermediate term and 10 percent operating. The O-O farm will thus have debt in all three categories. For the F-R and B-R farms, all debt was intermediate and operating, with 90 percent in the former and ten percent in the latter. These assumptions on debt structure approximate that of farms with herd-sizes of 40 to 49 cows in the PFA records and are in line with FCS lending policies in 1981. If a negative cash flow emerges during the five-year period all necessary borrowing to cover the deficit occurs as an operating loan. Thus, no refinancing on long- and intermediate-term debt was allowed. All debt repayment schedules were assumed to have equal annual combined principal and interest payments.

Three rental rate levels were used for the F-R and B-R farms to determine the effect that different rates have on financial solvency. For the F-R farm the annual rental rates for land (118 acres) and facilities were \$150, \$200, and \$248 per cow. The annual rates on facilities for the B-R farm were \$75, \$100, and \$125 per cow. It was assumed that the necessary equipment for feeding and milking was included in the facilities rental rate. Actual rental rates in Pennsylvania are unavailable, but it is expected they would fall within the ranges used here. In a 1981 report Dum found that the annual ownership cost of a new facility for a 50-cow herd was \$188 per cow and an equitable lease payment would range from \$150 to \$250 per cow. Rental rates for used facilities would be lower. Using 1981 PFA data for herds with 40 to 50 cows, the amortized value of facilities ranged from \$90 to \$100 per cow assuming a maturity of 35 years and an interest rate of 10.75 percent. The range of rental rates assumed for the B-R farm are in line with these values. The average 1981 rental rates for cropland in Pennsylvania was \$37.50 per acre (Pennsylvania Crop Reporting Service.) Using rental rates of \$25, \$35, and \$45 per acre for 118 acres results in land rates per cow of \$74, \$103, and \$133, respectively. Combined land and facility rental rates of \$150, \$200, and \$248 per cow are thus in agreement with actual land rental rates and the calculated amortized value of building facilities in 1981. However, land rental rates of \$100 or more per acre are not uncommon in the more productive southeast region of the state.

Federal income taxes were included assuming the couple was filing jointly. The operator and spouse were allowed the standard \$1,000 deduction, plus a general standard deduction of \$3,400. The farms were assumed to earn no off-farm income.

The starting level of investment for the three O-O farm alternatives was \$215,021 for the 13,000-pound producer, \$216,221 for the 15,000-pound producer, and \$230,421 for the 17,000-pound producer. For the F-R farms, starting levels of investment were \$98,568, \$99,768, and \$113,968 for the 13,000-, 15,000-, and 17,000-pound producers, respectively. The B-R farm started with investments of \$78,500, \$80,000, and \$97,750 for the 13,000-, 15,000-, and 17,000-pound producers, respectively. Differences in investment levels within each farm business type were due solely to the higher capital costs of the more productive cows.

The farm alternatives were simulated over a five-year period under specific input and output price trends. Milk prices were decreased to \$12.50 in 1982 and to \$11.58 in 1983 and increased to \$12.32 in 1984 and to \$13.13 in 1985. The market prices received for calves, heifers, cull cows, hay, and corn grain were assumed to remain constant at 1981 levels. Cash operating costs were taken from the 1981 PFA records for farms of similar size (see Grady for a detailed description). Operating costs on the O-O and F-R farms in the first year of operation were \$45,508, \$50,171, and \$54,300 at the 13,000-, 15,000-, and

[2] A two-year repayment schedule was used to conform to the definition of operating debt as used by the Pennsylvania Farmers Association. For livestock, a repayment schedule of seven years is not uncommon if the loan is part of a comprehensive loan package. A dairy livestock loan by itself will usually have a maturity of five years.

17,000-pound production levels, respectively. For the B-R farm these costs were $70,001, $74,313, and $75,326 respectively. All expenses, with the exception of interest, insurance, and building and machinery repairs and maintenance, were increased at a rate of 4.9 percent per year for all farms. Interest expenses were charged on the basis of the principal outstanding at the beginning of each period. When additional operating credit was required, the interest charged was equal to the base rate assumed in 1981. Rental rates for the F-R and B-R farms were fixed over the five-year period. If surplus cash was generated it was not invested off the farm to earn interest income. In most cases the surplus cash flow was small in any one year.

Results

The results of the 42 different farm alternatives simulated are summarized in table 1. Each alternative reported is optimal in the sense that the beginning level of equity investment to achieve financial solvency at the end of the fifth year was minimized. A lower level of equity, and therefore more debt, would result in an infeasible solution and a higher level of equity would result in a positive net cash flow after taxes and family withdrawals. As expected, the level of equity necessary to achieve financial solvency by the end of the five-year period differed by farm business type and the assumptions on milk production, source of financing, and rental rates. The O-O farm that was able to start with the lowest percentage of equity, and hence the highest percentage of debt, was that producing at 17,000 pounds of milk per cow and using FmHA financing. Beginning equity was $71,579, which was 31.1 percent of the $230,421 initial investment. Given the assumptions made on production, resource utilization, and prices, this farm could start with a debt load of $3,971 per cow. The necessary levels of starting equity for the farms producing at $13,000 and 15,000 pounds of milk were larger at $116,964 and $87,806, even though the initial levels of investment were less. The farm producing at 13,000 pounds could only handle a debt load of $2,451 per cow. The farms producing at 15,000 and 17,000 pounds of milk per cow showed a gain in equity after depreciation over the five-year period. The 17,000-pound average farm showed the largest absolute increase at $19,073. This farm was able to increase its equity more than the lower producing farms because it had a higher revenue and was not forced to borrow short-term debt to meet long- and intermediate-term debt repayments.

Under FCS financing the necessary level of beginning equity increased due to the larger annual interest payments. Additional starting equity investments of $13,845, $20,846, and $27,136 were needed for the farms producing at 13,000, 15,000, and 17,000 pounds, respectively. Because of the high levels of refinancing with operating debt, the farm producing at 13,000 pounds of milk showed a decrease in equity over the five-year period. These results demonstrate that even at high levels of milk production and using cheaper FmHA financing, a beginning owner-operated farm would need a sizable amount of initial equity to enter production and be financially solvent at the end of a five-year period.

It was noted earlier that depreciation was not being replaced over the five-year period. However, if a farm can meet the debt payments and maintain or increase the starting equity position, it would be in a favorable position to secure new loans to replace depreciated items. In the above situations, the farm producing at 13,000 pounds of milk under both sources of financing showed a decrease in equity. As a result, its potential borrowing capacity could be reduced and make further debt financing of intermediate-term capital items more difficult.

The necessary levels of starting equity, but not necessarily the percent equity, were less for all the alternatives simulated for the F-R farm and all but four of the B-R farm alternatives as compared to the O-O farm alternatives. This was due primarily to the smaller initial levels of investment necessary to enter production. The initial investments for the F-R and B-R farms ranged from 46 to 49 and 37 to 42 percent of those required by the O-O farms depending on the level of milk production. As expected, the lowest level of initial equity required for both farm types was at the highest production level, with FmHA financing and the lowest rental rate. For the F-R farms, the farm producing at 17,000 pounds of milk, with FmHA financing and paying a $150 per cow rental rate on buildings and land, could successfully enter production and be financially solvent at the end of the five-year period with

Table 1. Simulated Results for Financial Solvency

Farm[a] Type	Cwt. Milk Per Cow	Source[b] Financing	Rental Rate Per Cow	Percent[c] Starting Equity	Beginning Equity	Ending[d] Equity
0-0	130	FmHA		54.4	$116,964	115,842
0-0	150	FmHA		40.6	87,806	93,780
0-0	170	FmHA		31.1	71,579	90,642
0-0	130	FCS		60.8	130,809	119,977
0-0	150	FCS		50.3	108,652	108,920
0-0	170	FCS		42.8	98,715	107,163
F-R	130	FmHA	$150	46.2	45,547	56,171
F-R	150	FmHA	150	26.5	26,406	50,744
F-R	170	FmHA	150	18.3	20,824	62,771
F-R	130	FCS	150	50.9	50,187	58,728
F-R	150	FCS	150	33.0	32,925	52,298
F-R	170	FCS	150	25.5	29,069	59,188
F-R	130	FmHA	200	54.7	53,932	58,725
F-R	150	FmHA	200	33.6	33,514	52,893
F-R	170	FmHA	200	24.3	27,710	60,870
F-R	130	FCS	200	57.9	57,102	59,565
F-R	150	FCS	200	39.7	39,601	54,466
F-R	170	FCS	200	31.3	35,691	62,895
F-R	130	FmHA	248	63.3	62,386	61,198
F-R	150	FmHA	248	40.0	39,936	55,105
F-R	170	FmHA	248	30.3	34,586	63,008
F-R	130	FCS	248	66.2	65,286	61,944
F-R	150	FCS	248	46.0	45,931	56,529
F-R	170	FCS	248	36.8	41,908	64,840
B-R	130	FmHA	75	88.9	69,788	72,665
B-R	150	FmHA	75	54.7	43,773	66,365
B-R	170	FmHA	75	38.5	37,604	81,758
B-R	130	FCS	75	90.1	70,693	73,483
B-R	150	FCS	75	58.5	46,781	68,408
B-R	170	FCS	75	43.7	42,668	80,117
B-R	130	FmHA	100	94.8	74,401	71,649
B-R	150	FmHA	100	60.0	48,033	67,454
B-R	170	FmHA	100	43.2	42,271	82,876
B-R	130	FCS	100	95.5	74,924	76,562
B-R	150	FCS	100	63.7	50,944	69,187
B-R	170	FCS	100	45.6	44,539	82,538
B-R	130	FmHA	125	e	e	e
B-R	150	FmHA	125	65.7	52,567	67,629
B-R	170	FmHA	125	47.4	46,348	83,033
B-R	130	FCS	125	e	e	e
B-R	150	FCS	125	68.6	54,897	74,621
B-R	170	FCS	125	51.6	50,426	81,283

[a]0-0 = owner operator F-R = whole farm renter; B-R = building renter

[b]FmHA is the Farmer Home Administration and FCS is the Farm Credit System.

[c]Percent of the total investment in equity necessary to be financially solvent at the end of the five-year period.

[d]Dollars of equity at end of the five-year period.

[e]An infeasible solution with 100 percent equity financing.

$20,814 of beginning equity. This was 18.3 percent of the starting investment of $113,968. The debt load per cow was $2,329. Over the five-year period this farm increased its equity by $41,947. At milk production levels of 13,000 and 15,000 pounds per cow the farms could not carry as much debt, and the necessary levels of starting equity were thus greater at $45,547 and $26,406, respectively. Because of the financing of intermediate-term debt with operating debt, these farms showed smaller gains in equity. Using FCS financing increased the necessary starting levels of equity by approximately $5,000 to $8,000 across the three levels of milk production.

Increasing the rental rate by increments of $50 per cow to $200 and $248 resulted in increases in starting equity of approximately $6,000 to $14,000. At these rental rates, the higher priced FCS financing resulted in a larger absolute change in the starting level of equity on the higher producing farms as compared to the results found under FmHA financing. With a rental rate of $248 per cow, the farm producing at 13,000 pounds of milk was unable to show a gain in equity by the end of the fifth year under either source of financing. This was due to the frequent refinancing of intermediate-term debt with operating debt.

The starting levels of investment for the B-R farm alternatives were less than those for the F-R farm alternatives at all milk production levels. The B-R farms had no investment in crop production machinery and equipment, but did have a larger investment in the milking herd and replacement heifers due to the larger herd size. At the 17,000-pound herd average, with FmHA financing and a rental rate of $75 per cow, the necessary level of beginning equity was $37,604. This was 38.5 percent of the starting investment of $97,750. This farm could carry a starting debt load of $1,504 per cow. The gain in equity over the five-year period was $44,154. At the 13,000- and 15,000-pound production levels the necessary starting levels of equity were $69,788 and $43,773, or 89 and 55 percent of the starting levels of investment. In terms of debt per cow, the debt loads were $218 and $906. Using higher priced FCS financing had a larger impact on the beginning level of equity on the higher producing farms. Increasing the building rental rate by increments of $25 dollars per cow had a larger impact on the beginning equity of the lower producing farms.

Notably, at a rental rate of $125 per cow the 13,000-pound producer could not enter production and be financially solvent by the end of the fifth year with 100 percent equity financing.

Implications and Conclusion

These results clearly demonstrate that significant financial barriers impede successful entry into dairy production in Pennsylvania. While new entrants may strongly prefer to be owner-operators, they will find that the necessary level of starting equity is prohibitively large even at high levels of milk production and with the assistance of cheaper FmHA financing. Few beginning young farm families have accumulated savings of $70,000 to $100,000 to invest in a dairy farm. For the low-equity beginning farmer entering production as a whole-farm renter or a building renter and feed purchaser offers more promise for financial success. The results show that a whole-farm renter with a starting equity base of $20,824 could enter production and be financially solvent by the end of the fifth year only at high levels of production. However, few beginning farmers may be able to average 17,000 pounds of milk per cow in the first few years of operation.

The necessary amount of equity increases significantly when higher interest and rental rates are used. When compared with the building renter, the whole-farm rental alternative offers the beginning farmer the best chance for successful entry at low beginning equity levels. In addition, the percentage gain in equity is in general slightly larger for the whole-farm rental situation. The building renter is in a less favorable situation due to the purchasing of all feeds.

While the change in equity over the five-year period was not included as part of the financial solvency criterion, it can have important implications for securing future loans. Depreciation on machinery and equipment was not included in the analysis even though these items must be replaced in subsequent years. If a farm can add to its equity base, additional debt financing to replace depreciated items would be possible. Replacing depreciated facilities would only be necessary after an extended period of time.

The results derived here could change significantly under a different set of assumptions. Caution should be used in extrapolating these results to fit situations that do not fall within the bounds of the model assumptions. In general, the assumptions established are in line with behavior and outcomes on Pennsylvania dairy farms with herd sizes of 40 to 50 cows.

An important factor not considered in this analysis is the risk involved in dairy farming. In a recent case study approach of 37 beginning farmers in New York, Smith and Brake found risk to be a factor of major concern. Farm operators face a host of uncontrollable factors relating to crop and milk production, financing, and market prices under even the best of plans. Accounting for risks in the alternatives analyzed would undoubtedly result in an increase in the starting levels of equity.

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Negatively Taxed Farm Expansion Investments

Gregory D. Hanson

Abstract

The issue of a negative tax on combined land and machinery investments is explored in a sample of Minnesota farms from 1972 to 1978. The expansion investments on ten farms that satisfied test criteria generally resulted in lower tax liabilities and higher tax shielded income. Inclusion of opportunity interest on equity (important for economic decision-making, although not tax deductible) increased annual per farm negative taxation from $533 to $1,546. Preliminary results suggest large tax offsets may be pervasive in combined land-machinery expansion investments. This may result in economic resource allocation inefficiency and affect increases in agricultural real estate prices as land costs are included in cost of production support prices. Critical issues include the amount of equity interest opportunity costs allocated in the model, the assumption that expansion acres are of similar quality to previously owned land, and the likelihood of a continuation in the long-term land inflation trend in U.S. agriculture.

Tax effects upon growth have been traditionally explored in the framework of cost curves. The cost curve approach permits verification of theory, providing a test within the environment or constraints (e.g., cash flow requirements, fluctuating yields and prices, etc.) actually faced by farm operators. In addition, the presentation of before and after tax cost curves constitutes a visually accessible approach within the mainstream of economic analysis of agricultural structure issues. Cost curve analysis recognizing "tax offsets" can distinguish a phenomenon with scale and resource allocation effects not usually anticipated: negative taxation. (The issue of negative taxation in agriculture was recently raised for perhaps the first time in a tax policy study by Davenport, Boehlje, and Martin.)

It will be suggested that producer tax management behavior partially accounts for the widely recognized phenomenon that "Land prices have been bid up to a point where negative cash flows from a land purchase are the rule rather than the exception" (Kay, p. 258). Recent support for the view that the U.S.

Figure 1. Effect of Neutral Income Tax on Costs

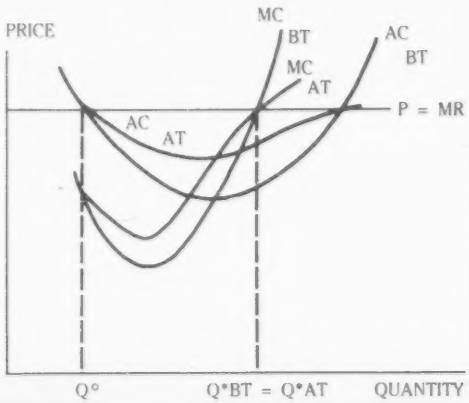

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Table 1. Present Value of Deductions Associated with $40,000 Tractor Purchase, 5-Year Class Life, ACRS Depreciation

	Year				
	1	2	3	4	5
Deduction Value of Investment Credit	13333[a]				
Depreciation (ACRS)	5700	8360	7980	7980	7980
Present Value Total Deduction	19033	7464.29	6361.61	5680.01	5071.43
Total Present Value (.12)	43,610.34				

[a]The tax deductions equivalent of a tax credit D = C/t, where t is the marginal tax bracket of the investor (.3), and C is the credit amount. The depreciation basis has been reduced by 50 percent of the $4,000 investment credit.

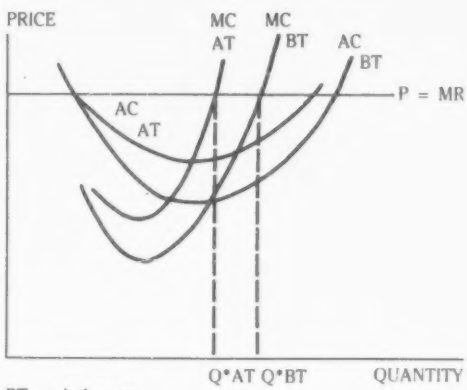
income tax system provides powerful investment incentives is provided in two opinion surveys of farmers (Otto). For example, 64.8 percent and 55.8 percent of the respective Iowa and Alabama respondents strongly or moderately agreed that "People often buy land to lower their tax burden" (p.11). More than 95 percent of the Alabama respondents and 82 percent of the Iowa respondents similarly agreed that the income tax system encourages machinery purchases in years of high income (p. 11).

Tax Expenditures in Traditional Cost Curve Models

Until perhaps the late 1960s, agricultural economists in general took for granted the textbook viewpoint that imposition of an income tax did not materially change optimal firm output. In effect, the tax allowances for such things as depreciation were assumed to be correct in an economic cost perspective. This situation is depicted in figure 1, where after tax marginal costs are shifted up between Q° and Q^{*}. Government revenues increase ($AC\text{-}AC_{BT}$), but the tax does not affect the profit maximizing activity.

Dean and Carter pointed out in 1962 that if a major cost such as the opportunity cost of equity capital was not tax deductible, optimal output would be less than before tax output. This situation is portrayed in figure 2. However, equity financing is no longer the typical case in farm land investment. Additional purchases of land are frequently highly leveraged (the down payment may actually be borrowed against equity derived

Figure 2. Effect of Nondeductibility of Opportunity (Equity) Interest on Costs



BT = before tax
AT = after tax
Q* = optimal output

from appreciation of past land purchases). With respect to machinery purchases, recent trends to accelerate depreciation have resulted in the possibility that the present value of tax deductions (including the deduction value of the investment credit) can actually exceed the cost of the investment. This is illustrated in table 1. Observe that for an investor in the 30 percent marginal federal income tax bracket with a 12 percent discount rate, the present value of tax deductions exceeds the $40,000 tractor purchase price by $3,610.34.[1]

[1]The tractor is assumed purchased at year end, a not uncommon practice. This result is obviously sensitive to marginal tax bracket and discount rate assumptions. Selection of a 14 percent rate and 40 percent marginal federal income tax bracket results in the present value of tax deductions to be less than the purchase price by $715.24.

Negative Taxes and Cost Curves

When an investment can be written off immediately, it is effectively tax exempt (e.g., Musgrave, p. 343-344). Since in the above example the present value of deductions exceeds purchase price, the effect is stronger than "tax exempt." If the excess deductions can be used to offset previous farm investment income, off-farm investment income, and/or personal income, then the investment generating the tax exemptions can be viewed to be negatively taxed. In addition to depreciation and the deduction value of investment credits, "deductions" affecting the tax attractiveness of investments include (a) exclusions from income such as capital gains deductions and (b) the reduction of taxable income resulting from a shift to a lower tax bracket from a higher current bracket (Bailey). These deductions can affect the tax implications of a machinery purchase if machinery is viewed to be one component of a holistic land-machinery expansion decision. That is, machinery is viewed to be a necessary complement of land expansion (a production-farm management perspective of complementary inputs).[2] Moreover, it can be argued that under current grain input and output price conditions, ordinary income will not likely be generated by the machine (during its lifetime) if accompanied by a highly leveraged land purchase. Sales revenues from corn and/or soybean production may cover variable production costs, but not the interest payment on land purchased with a low down payment at current land price and interest rate levels. The tax loss that can be anticipated on expansion land-machinery investment has value in that it offsets ordinary taxable income on previous investments that are now profitable; e.g., at current commodity price levels (more generally, the tax loss offsets "other income," whether farm or nonfarm).

If the land-machine expansion assets are viewed as complementary inputs, and annual land inflation is expected to occur as a result of the combination of technological advancement, increasing government price supports, and/or general inflationary trends, then the return to the machine investment will ultimately be capitalized into land appreciation. Thus, a combination land-machine expansion converts ordinary income to capital gains income in the form of additional land appreciation.[3] As such, some of the gain will escape taxation; in any case, taxation will be delayed. The gain could escape taxation completely upon death of the purchaser depending upon size of the estate. Finally, note that while tax liabilities associated with income from the asset expansion are at a minimum postponed, and tax liabilities on "other income" are reduced, the purchaser frequently will have the opportunity to borrow against the appreciation on the land purchase as it takes place.

Land-machinery investments may generate both large tax offsets and substantially tax-shielded income in the form of land appreciation (based on long-range land appreciation trends in agriculture). This comprises an ideal form of negatively taxed investment because it has been (a) profitable and (b) quite possibly more profitable than if it were not subject to the income tax since the tax offsets could not be utilized to offset other income. In addition, real estate taxes, variable production expenses and especially interest expense are cash costs that affect the tax-shielding value of land-machinery investments. One can argue that in the past the economic return to an important fraction of these costs was in the form of unrealized capital gains. Just as it is appropriate that these cash costs be included in the benefit-cost analyses of

[2]It is acknowledged that land expansion occurs frequently with little or no concomitant machinery investment. However, from a production perspective tillage of additional acres demands that additional costs be allocated for increased wear on machinery. In terms of "use depreciation," the remaining life of a machine is decreased as more acres are plowed, planted, harvested, etc. Thus although a land purchase may not be immediately accompanied by additional machinery investment, machinery replacement schedules will be accelerated.

[3]Since the early 1940s, land appreciation has occurred annually in U.S. agriculture with the exceptions of 1950, 1954, and 1982-1983 (Statistics of Agriculture). The large cost of the Payment-In-Kind Program during 1983 has in this context been referred to as "the cost of land price stabilization." Referring to the tendency for income gains to be capitalized into the limiting input—land—Cochrane writes "The ultimate gainer from a net income increase in agriculture, whether resulting from an increase in demand, a farm technological advance, or a farm program, is the land owner" (p. 371). Melichar recently advanced the view that land is primarily valued as a "growth stock" for its capital gains potential. A brief current discussion of the relationship of farm price and income supports to farm assets is found in Brake.

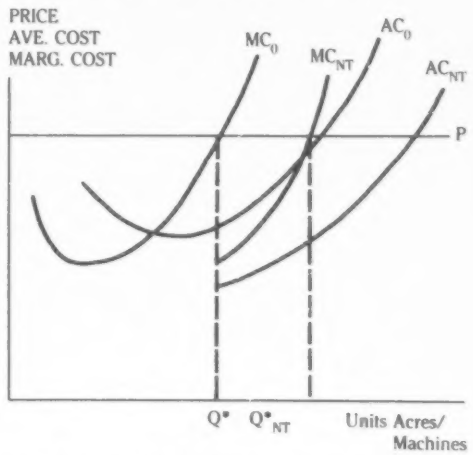
expansion investments, these cash costs are also included in this study's before tax-after tax cost analysis (also consistent with Dean and Carter's treatment).[4]

Acquisition of assets that generate tax relief instead of additional taxes can dramatically change the cost-scale model. Instead of taxes shifting optimal output left as hypothesized by Dean and Carter, the opposite may occur, as is illustrated in figure 3. The before-tax optimal output (Q^*), is determined by the intersection of before-tax marginal cost (MC_0) and product price (P). Q^*_{NT} less Q^* denotes units production of expansion assets. (Note that in this model, expansion assets as well as expansion production are identified; this marginalist convention allocates tax savings to the production unit whose purchase has in fact made the savings possible.) MC_0 less MC_{NT} can be interpreted as the marginal tax savings that result from excess deductions on the expansion investment. In effect, the tax savings property of the expansion investment has reduced after-tax marginal costs of MC_{NT}, and optimal output correspondingly shifts from Q^* to Q^*_{NT}. The size of the production effect is determined by the production function and the level of tax offset generated by the negatively taxed investment. (The tax subsidy 'size effect' will prevail until the increase in marginal costs associated with expansion eclipses the favorable effect of tax offsets). In sum, unique opportunities for negatively taxed investments in U.S. agriculture provide an incentive to expand firm size in the presence of other taxable income. Farm investments with this quality will eventually find their way into the investment portfolios of persons (farmers or nonfarmers) who do in fact have sizable other income.[5]

Test Criteria and Methodology

This section illustrates criteria for an empirical test of negatively taxed investment in a farm-records time series and the tax and accounting technique used to determine if expansion investment resulted in reduced taxes and increased economic income.

Figure 3. Effect of a Negatively Taxed Investment on Costs



Effect of negatively taxed yield on optimal output level.

Q^* = optimal output before tax
Q^*_{NT} = optimal output after negative tax

Test Criteria

Ideal observations for testing the occurrence of negatively taxed agricultural investments would be farms that strictly produce grain for market, do not anticipate expansion until the actual time the expansion occurs, purchase the expansion property in an arms-length transaction, and provide information on the terms of the transaction (i.e., purchase price, mortgage amount, interest rate, and amount of annual payment). This degree of detail is simply unavailable in large farm-record data sets.

The criteria chosen for case selection in this study are: Tillable acres purchased must be greater than or equal to 40, purchase date to be 1972 or later, purchase of expansion land must increase total acres farmed, and cases with large purchases of feeder cattle or frequent changes in acreage are excluded. These modified criteria attempt to ensure that the acres purchased: require production reorganization and thus be considered as a true expansion; set the expansion in a recent time period typical of current conditions; relate machinery and buildings purchases more

[4]In this respect, Bailey includes cash costs of land clearing in a land purchase example where negative taxation "converts a negative social yield to a positive after-tax private yield" (p. 1161).

[5]Penson found farm families accumulated significant amounts of nonfarm equity capital during the 1970s. In 1973-1974, nonfarm capital accumulation among farmers almost equalled farm capital accumulation.

directly to the land expansion (than would be the case had the expansion land been farmed prior to purchase); simplify allocation of expense and revenue in multi-enterprise farms; and exclude cases where rapid consecutive changes in acreage lend themselves to interpretation and programming difficulties.

Allocation of Expansion Revenues and Expenses

Allocation of expenses and returns to enterprises has been, from the farm record standpoint, a difficult issue requiring enterprise allocation assumptions not readily verifiable. The first key assumption in this analysis is that a tillable expansion acre is indistinguishable from pre-expansion tillable acres (the homogeneous acres rule). This permits allocating an input such as fertilizer by the ratio of tillable expansion acres to total tillable acres (after expansion). The homogeneous acres rule permits allocation of crop production value and expenses that are entirely related to crop production (such as fertilizer, pesticides, repair of crop machinery, etc.).

The second allocation assumption is that inputs shared by both crop and livestock enterprises be allocated by the ratio of crop sales to total sales. This assumption is directed at another major category of inputs including interest and depreciation on buildings, electricity, wages, and general farm expense that are shared by both crop and livestock enterprises. The crop share of these expense items is then allocated to the expansion land by the ratio of tillable expansion acres. Inputs such as veterinary, feed purchased, and miscellaneous livestock expenses are clearly not related to the grain enterprise, and can be ignored in land-machinery expansion analysis.

The Tax Simulation Model

The methodology is primarily tax accounting based on a time-series cross section of comprehensive farm record data that includes tax as well as economic variables. An income tax simulation model TAXMODL was used to estimate combined state and federal income and self-employment (social security) taxes individually for each farm. The steps in the model are (1) calculation of adjusted gross income, (2) comparison of the standard personal deduction to itemized deductions, (3) computation of base state and federal income and self-employment taxes, (4) adjustment of base taxes with available business and personal deductions and credits, and (5) estimation of final annual tax liabilities for each tax on income.[6]

The above TAXMODL simulation was first performed based on the total sales, cash expenses, depreciation, and other tax information available in the farm record data. Crop production revenues and expenses attributable to the land expansion are then subtracted from the firm and a second run of TAXMODL is conducted. If tax liabilities have increased compared to the initial run, the land expansion assets qualify as negatively taxed investments (as explained earlier).

The Data

The data base for the study is comprised of farm financial and production records from farm management associations in southern Minnesota. The 76 farms in the sample completed a record each year of the study period 1967-1978, were unincorporated single proprietorships, and maintained the same operator identity between 1967 and 1978. Farm sales and assets averaged respectively $87,500 and $299,700 during the 12 years of the study period. By the last year of the study, 1978, sales had grown to $136,700 and assets to $639,000. Land values were adjusted annually based on county-wide land value surveys of real estate agents, land brokers, and bankers. Machinery and buildings were valued at cost less depreciation; livestock at year-end estimated market prices by the farmers. Major enterprises in the sample consisted of corn, soybeans, hogs, feeder cattle, and dairy.

In addition to farm cashflow and production information, the records include several categories of other income: miscellaneous farm income, labor and machinery custom work

[6]Model tax provisions include: low income credit, income allocation to spouse, net operating loss carry over-carry back, minimum tax (state income tax); earned income credit, optional self-employment method (self employed tax); low income allowance, income averaging, investment credit carry over-carry back, tax surcharge, general credit, net operating loss carry over-carry back, minimum tax (federal income tax). Not all these provisions were in effect every year, and some were modified from 1967 to 1978 as well (such as investment credit rates). Annual changes in tax rates and tax savings provisions for 1969-1978 are included in TAXMODL. See Hanson, p. 60-73.

receipts, patronage refunds, investment income, other nonfarm income, and farm program payments. Family size (personal deductions), church and charitable contributions, medical expenses, income and self-employment taxes, and income tax refunds are also included.

During the years 1972-1978, land expansion greater than 40 tillable acres occurred on 26 of the 76 sample farms. In only 12 of these cases did the land purchase increase acres farmed (in 14 cases the land had been rented for more than one year prior to purchase). Of the 12 cases where expansion occurred with purchase, two farms purchased large amounts of feeder cattle. Thus, the negative tax test was conducted on ten cases.

Three of the ten test cases did not produce livestock products. For these farms, estimation of revenues from expansion assets was obtained on a pro rata basis based on the expansion share of total tillable acres. Thus, if sales in a particular year were $100,000 and 100 of total 400 tillable acres were expansion acres, $25,000 in sales were allocated to the expansion investment (100/400 times $100,000). For the remaining seven farms, value of expansion production was based upon bushels of corn, soybeans, oats, and wheat, and tons of alfalfa produced. These production units were then multiplied by the respective product prices used for enterprise analysis by the farm management associations.

Negatively Taxed Expansion Investments

Expansion investment occurred during 1974-1978 for the ten farms satisfying the test criteria (no land expansion took place for these farms during 1972-1973). Tax and expense detail is provided in table 2 on an annual per farm basis (cash and noncash deduction items and their relative size compared to total farm deductions are indicated).

The interest allocation is the first expense number, i.e., $4,084 in 1974. This is the amount of interest actually paid that can be attributed to the expansion investment. Had the entire investment been financed, the difference in pre- and post-expansion tax would be $1,546 instead of $533 (table 2, lower right) and all farms would have experienced negative taxation. The apparent reason for the large equity contribution to the expansion investment was the tremendous increase in farm incomes, particularly from 1972-1975. Compared to the preceding four years, average net income of farm operators increased 86 percent during 1972-1975 (49 percent in 1967 dollars, Statistics of Agriculture). However, had the farmers not employed their increased earnings to expand farm assets, income would have increased by market interest earned on the expansion investment equity. Assuming a nine percent pretax interest rate on that part of the expansion that was financed from equity, the tax computation program estimated that tax liabilities would have increased from $4,449 annually to $5,995 (a $1,546 increase) in the no-expansion case. (Conservative interest rates of eight percent and ten percent for land and machinery loans respectively were assumed in the analysis. While the amount paid for expansion land and buildings was indicated in the farm records, financial terms were not.)

The sum of interest paid, depreciation, and the deduction value of the investment credit is $12,858, or 51 percent of total average deductions for the years 1974-1978 (table 2.) This indicates the large effect tax and financial leverage factors have in investment analysis.

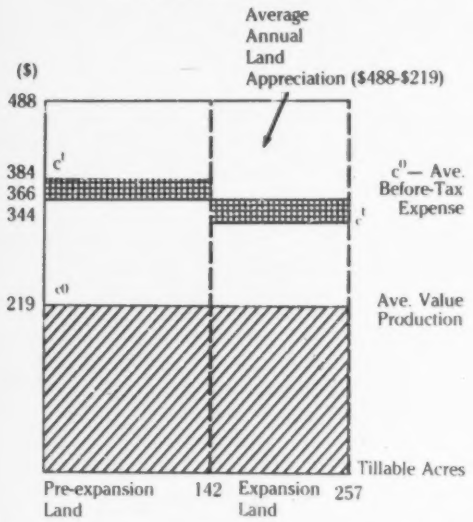
Because annual estimated tax liabilities declined $533 as a result of expansion, or $1,546 depending upon level of financing assumed, and expansion income in the form of land appreciation averaging $25,790 was shielded from taxes (table 2, lower right), sample expansion investments appear to have been negatively taxed. Exclusion of investment credit on the original depreciable assets of the real estate expansion provides an element of conservatism to this estimate. The outstanding result of negatively taxed land-machinery expansion is a significant increase in personal wealth and a reduction of tax liabilities. Further, the after-tax expansion costs are lower on the added acreage than on the pre-expansion acreage. These effects are illustrated in figure 4 for the farm with the second highest level of excess deductions among the test cases.

The line C' denotes production expense including opportunity interest on pre-expansion tillable acres. The cross-hatched area to the left of 142 acres represents tax

Table 2. Average Expense, Revenues, and Tax Liabilities Allocated to Combined Land and Machinery Expansion Purchases

Item	1974	1975	1976	1977	1978	Annual Average 1974-1978
	($)	($)	($)	($)	($)	($)
Interest Allocated (Maximum Allocable Interest)	4084	4970	4888	5449	4518	4830
Land and Buildings	6191	5560	5792	6312	6209	6039
Machinery	805	883	981	1063	1235	1021
Depreciation	4943	5066	5797	6186	7664	6098
Machinery	2394	2669	2661	2544	3655	2838
Buildings	2069	2143	2908	2780	3574	2786
Truck and Auto	480	254	228	862	435	474
Real Estate Tax	642	988	1030	1509	1465	1189
Machine Repair	945	1001	1168	1516	1824	1356
Gas, Oil, Lubricants	714	676	776	1187	1416	1006
Fertilizer, Chemicals	4579	5350	4862	5820	7231	5715
Wages, Custom Work, General Expense	2931	2369	2724	3264	4101	3161
Investment Credit Deduction Value	1441	924	1662	1612	3461	1930
Total Expense (Deductions)	20280	21345	22907	26543	31696	25286
Revenues	20882	19139	17848	22392	26625	21761
Excess Deductions	(602)	2206	5059	4151	5071	3525
Change	220	-991	-1309	-337	-238	-533
Tax With Expansion	6392	5705	5167	2692	3588	4449
Tax Without Expansion	6172	6696	6476	3028	3826	4982
Change Tax when Maximum Interest was Allocated	- -	- -	- -	- -	- -	-1546
Expansion Land Appreciation	23603	20828	27612	26210	28700	25790

Figure 4. Negative Taxation Effect on Average Marginal Cost[a]



[a] Based on farm with second largest negative tax savings, averages for 3-year period 1976-78 (expansion occurred beginning 1976). Average after-tax cost on pre-expansion 142 acres is compared with after-tax cost (including tax savings) on 115-acre expansion. Opportunity interest cost included on pre-expansion farm land.

liabilities in the absence of expansion, or $2,505 divided by pre-expansion tillable acres. Taxes increased costs approximately $18 per tillable acre from $366 to $384.

The cross-hatched area to the right of the pre-expansion point likewise indicates the value of excess deductions on the expansion acres. That is, crediting the $2,505 tax savings to the asset that actually contributed the savings—the expansion investment—lowers after-tax cost from $366 to $344 per acre (note the expansion reduced the farmer's tax liability to zero). Both cross-hatched sections are of equal area for this farm since tax savings on the expansion investment equals tax liabilities had no expansion occurred. Since the upper border of the left hand cross-hatched area represents the pre-expansion cost after tax, while the lower border of the right hand cross-hatched area represents the after tax cost on the expansion land, the line C^0C^1 can be viewed as a declining average cost curve or "marginal" average cost curve. Note also that the after-tax average cost curve on the expansion investment lies below the before-tax average cost curve pointing out the nature of this negatively taxed investment. The decline in after-tax costs can be viewed as an incentive for expansion in the traditional cost curve framework.

During the years analyzed, estimated average annual appreciation was $269 per acre (figure 4, $488-$219). Even after discounting this capital gain, inclusion of this area transforms a social loss into a personal economic gain.[7] Note also that the increase in land value may serve as a mask for inefficient production practices, offering a positive reward to those that can manipulate their cash flow to handle a land expansion (although not necessarily practicing the most efficient production practices).

Summary and Suggestions for Future Research

The tax-investment model illustrates how investment related expenditures may result in tax deductions which shield income otherwise unprotected from taxes. Income from expansion investments frequently takes the form of land appreciation, and consequently benefits from capital gains deductions and/or estate tax subsidies. Viewed from this perspective expenditures on combined land and machinery investments may result in large tax reductions that produce a downward shift in after-tax marginal and average cost curves providing clear incentives to expand production. In the study ten of the 76 farmer sample met rather stringent negative taxation test criteria, and of these seven were found to have experienced negatively taxed investment. While negative taxation may not be the typical case, its occurrence during inflationary periods, if verified, constitutes an intriguing result in view of long-run inflationary trends in agriculture since the 1940s.

While the results suggest that the occurrence of negative taxation of farm expansion investments is plausible, several insights were also provided. When 100 percent financing was assumed, all ten cases experienced negative taxation benefits. However, at the level of debt financing used, two of the seven

[7] Discounting the varying annual land appreciation gains by the eight percent interest rate assumed for real estate purchases reduces the average land appreciation from $269 to $216. In this case the combined value of appreciation and value production is $435, compared to the after-tax cost of production on expansion land, $344.

cases of negative taxation accounted for most of the tax savings. Off-farm income for the ten farms in the test was 3.4 times the average of the 76 farm sample as a whole during the years 1974-1978 indicating that this may be a factor. There was no clear indication that negative taxation is positively correlated with farm size. The average per acre price for expansion land was $581, while the estimated 1980 value of farmland in the sample region is between $1,500-$1,700.

Farmers can be expected to aggressively bid for expansion land-machinery investments, motivated in part by agricultural tax subsidies (especially during years of high farm prices). Several implications of this behavior are: first, the financial ability to take advantage of large available tax subsidies generated by expansion investment may profoundly affect the prevalent scale of production in agriculture. Second, food prices, if reflecting production costs that include land, will increase as income tax subsidies contribute to land inflation. Third, commercial farmers in pursuit of tax relief may experience lower effective tax rates than people of similar economic income who do not receive significant tax offsets (Sisson). Governments that raise revenues via the income tax may find that the agricultural share of collections declines for this reason (Economic Report of the President). Finally, while this framework may offer insight into one tax phenomenon, dynamic treatments based on high quality microeconomic and aggregate data sets are needed to provide agricultural tax policy analysis with respect to resource allocation and distributional issues.

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Consideration of Farmland Value Variation on Farm Firm Survival

Jerry R. Skees and Donald W. Reid

Abstract

This research demonstrates the importance of developing appropriate relationships between income risk and asset risk when modeling farm survival. If these interactions are ignored, the research may grossly underestimate risk and may lead to inaccurate conclusions regarding the relative risks that are inherent in different size farms. Without these interactions, the smaller farms appear relatively more risky. Since lenders continue to base their decisions on both asset values and cash flows, it is essential that farm survival research properly account for the relationships between income and asset values. The Monte Carlo simulation approach presented here offers one alternative.

Key words: farm survival, Monte Carlo simulation, Almon lag land model, risk, income and asset risk.

Jerry R. Skees and Donald W. Reid are assistant professors of agricultural economics at the University of Kentucky. The research reported in this article was conducted at the University of Kentucky Agricultural Experiment Station. The simulation model used for this study was developed at Michigan State University with the aid of a cooperative research agreement with the Farm Sector Branch, Economic Research Service, USDA. The investigation reported in this paper (No. 84-1-86) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the director.

The number of recent farm business failures has stimulated research interest on causes of failure and conditions necessary for survival of farm firms. In many of these studies the effects of financial structure, farm size, and farm income have been of particular interest. Hanson and Thompson used econometric simulation to determine maximum debt load by farm type and farm size. They found that the maximum feasible debt-to-asset ratio increases with farm size; however, they stressed farm type as possibly the most important variable in determining the successful use of credit. Absolute debt was based on asset values, and farmland was valued at estimated county averages.

Richardson and Condra used a dynamic Monte Carlo simulation-programming model to analyze survival of four sizes of representative irrigated farms in the El Paso Valley. Survival was defined as being able to meet cash commitments, including the ability to borrow against farmland and machinery up to a debt-to-asset ratio of 80 percent. Farmland was valued by applying an inflation factor to the beginning-year value. Results of this study indicated that chances of survival increase as farm size and/or beginning equity increase.

Held and Helmers also used simulation to study farm firm survival. Survival was defined as successfully maintaining a debt-to-asset ratio at or below 60 percent. Consistent with other studies, and as expected, the results indicated that as beginning equity increases and/or as the land appreciation rate increases the rate of survival also increases.

A basic weakness in the simulation studies of farm survival is that such studies ignore the relationship between farm income and farm

asset values. Farmland value is particularly significant because of its importance in debt financing. When land values are assumed to be independent of farm income (returns to land), a large component of risk is not considered in evaluating survivability. In periods of low farm income the security base (farmland value) for debt financing decreases; therefore, borrowing potential decreases. Casual observation for the past few years supports this view. The failure to consider this relationship between farm income and land value has implications for analyzing the effect of farm size on survival; as the proportion of farmland to other, perhaps, less risky assets increases, risk of failure may increase.

The purpose of this study is to determine the potential effect on farm survival when land values are explicitly related to returns to land. First, the return-land value relationship and the land value-liquidity reserve relationship are conceptualized. Then, empirical data and relationships are used to analyze four farm sizes to ascertain effects of land values on survival. The study utilizes a Monte Carlo simulation model of representative Illinois corn-soybean farms.

Conceptual Framework

Using asset valuation theory, land values can be conceptualized as the discounted value of expected return to land, i.e.,

$$V = \sum_{t=1}^{\infty} \frac{R_t}{(1+i_t)^t}$$

where V is the present value of land, R_t is the expected returns to land in period t, and i_t is the expected discount rate (required rate of return) in period t. Although this conceptualization abstracts from other influences on value, such as location, it (or some variation thereof) has been useful in explaining land values by many researchers (e.g., Castle and Hoch; Melichar; Reinsel and Reinsel; Lee and Rask; Harris).

Melichar's more restrictive formulation is useful in providing insights into the relationship of return to land and land values. His model is:

$$V = \frac{1+g}{i-g} R$$

where V is the present value of land, R is the current expected return to land, g is the expected growth rate of R, and i is the discount rate (required rate of return). In explaining historical increases in land values, Melichar notes that values can increase in two ways: (a) R, g, or i can change resulting in a new higher equilibrium V and (b) if $g>0$, but $g<i$, the equilibrium value V rises even if g and i remain unchanged. However, since returns to land are stochastic events, it is possible that enough low returns could occur to cause a downward revision in land market participants' expectations about R and g and, perhaps, change their perception regarding returns risk that would increase i. Furthermore, using Melichar's reasoning, if $g<0$, the equilibrium value, V, decreases even if g and i remain constant.

The fact that asset values and returns-to-assets are related has important implications for farm firm survival. Suppose survival is defined as being able to meet all cash commitments. Furthermore, assume that, in order to survive in any given year, cash commitments can be met by cash return on assets, cash reserves, or borrowings. Thus, the potential amount available for covering cash commitments (L) can be expressed as

$$L = \alpha A - \beta A + \bar{r} A + \alpha \tilde{g} A + CR \qquad (1)$$

where A is the value of assets occurring at the beginning of the year, α is the maximum debt-asset allowed by the lender, β is the actual debt-asset, $\bar{r}$ is the risky cash rate of return on assets, $\tilde{g}$ is the risky capital gain (loss) rate of return on initial asset values, and CR is beginning of the year cash reserves. The difference between αA and βA in equation (1) is the beginning of the year borrowing reserve; $\alpha \tilde{g} A$ represents the adjustment to the borrowing reserve because of asset value increases or declines. The $\bar{r}A$ component represents cash that can be used to meet commitments from current period earnings.

Because of risky components in L, there is risk associated with being able to cover cash commitments. Using variance as an indicator of risk, the variance of L is

$$\mathrm{Var}(L) = A^2\sigma_r^2 + \alpha^2 A^2 \sigma_g^2 + 2\alpha A^2 \sigma_{rg} \qquad (2)$$

where σ_r^2 is the variance of $\bar{r}$, σ_g^2 the variance of $\tilde{g}$, and σ_{rg} the covariance of $\bar{r}$ and $\tilde{g}$. From (2) it is apparent that risk of covering cash commitments increases when risk of changes in asset values is included and is positively

correlated to returns to assets. Therefore, a consideration of risky asset values should lower the probability of survival for each given debt-asset or, alternatively, the maximum feasible debt-asset should be lower.

The Simulation Model

A simulation model is used to demonstrate the potential importance of the return to the land-to-land value relationship in considering farm firm survival. The model develops the financial environment for Illinois corn-soybean farms with soil productivity ratings of 85-100. (The Illinois Farm Business Records describes those soils as "farms with nearly level, well-drained prairie soils.") In addition, these farms generally are highly specialized (over 95 percent of the total tillable acres planted with corn or soybeans). Farms with these characteristics are primarily in central and northern Illinois. These factors and available quality data were primary reasons for selecting this region and type of farming.

The simulation model is similar to many other models (e.g., Richardson and Condra, Held and Helmers) in that it relies on empirical and internally-developed economic and cash accounting relationships (described in Penson and Lins) to replicate a ten-year period. The recursive financial FORTRAN program is quite flexible (Skees). However, only those portions used for this paper are explained. Variable costs are developed for both corn and soybeans to facilitate crop mix decisions. The 1974-1979 annual *Summary of Illinois Farm Business Records* and the 1979 *Farm Earnings and Production Cost Summary* provide the basic production and cost data. Estimated quadratic equations and table look-up functions (which use linear extrapolation between data points) are used to tie the following items to tillable acres: (a) soil fertility cost, (b) machinery fuel and repair, (c) seed and crop cost, (d) machinery and building investment, (e) insurance and miscellaneous expenses, (f) total labor requirement, (g) family labor used, and (h) expected corn and soybean yields.

Each farm has 18 man-months of available family labor. When this labor is fully utilized (as determined by the family labor equation), outside labor is hired. Cost and production relationships are developed twice each simulated year: first, for planning purposes to select a crop mix that will maximize returns; and, second, for accounting purposes (using the random prices and yields). Expected prices are developed with naive exponentially smoothed equations and previous year's prices. Expected prices and yields are used in conjunction with a TELPLAN program developed by Black and Vitosh to select the crop mix. The program evaluates the returns from alternative crop mixes by using a yield discount matrix that accounts for trade-offs associated with different levels of specialization in either corn or soybeans given different (discrete) levels of machinery.

At year's end, cash flow projections and a full accounting of available revenue are made. Revenues include the current year's crop, custom harvesting with excess machinery, and interest earnings on outside investments. Cash outflows include out-of-pocket corn and soybean production costs, property taxes (set at .7 percent of the land value), federal income taxes, principal and interest charges on loans, family living withdrawals (a function of previous year's expenditures and after-tax farm income), and any down payment for machinery and building replacement.

Tax provisions of the 1982 tax act are used. For these experiments, grain is not stored. If the cash flow is positive, the excess is placed in a savings account with a return that is equal to the fixed interest rate. If cash flow is negative and there are no savings, short-term loans are acquired. (For these experiments, refinancing of land is not considered.)

For a multiperiod Monte Carlo simulation model, random prices and yields must be correlated within, as well as between years. Correlated random prices and yields were generated with a multivariate, Beta process generator developed by King and modified by Hoskin. A Beta generator was chosen over a normal generator because of the skewed nature of the distributions and the ability to place lower and upper bounds on the random draws (e.g., the lower bound on corn prices in the loan rate). Table 1 presents the parameters used to generate multivariate random corn and soybean prices and yields. Illinois farm-level yield data (1972-1979) were used to develop the yield parameters.

Since prices and yields are correlated between years, as well as within years, a random series

Table 1. Parameters Used to Generate Multivariate Random Corn and Soybean Prices and Yields

Item	Mean	Standard deviation	Upper bound	Lower bound
Corn price	2.67	0.35	3.60	2.25
Soybean price	6.95	0.84	10.04	5.90
Corn yield[a]	0	19.00	44.9	-57.40
Soybean yield[a]	0	6.10	14.8	-22.40
Summary of within year correlations[b]				
Corn and soybean prices		0.50		
Corn and soybean yields		0.55		
Corn yield and corn price		- .27		
Soybean yield and soybean price		- .27		
Summary of between year correlations				
$Corn\ price_t$ and $corn\ price_{t+1}$		.50		
$Soybean\ price_t$ and $soybean\ price_{t+1}$		.35		
$Corn\ price_t$ and $soybean\ price_{t+1}$		.30		
$Soybean\ price_t$ and $corn\ price_{t+1}$		.20		

[a]The distributions for yields were normalized around a mean of zero in order to provide model flexibility in adjusting expected yields for an individual farm. Expected yields vary as farm size and crop mix vary. Random yields are calculated by adding the random draw to expected yields.

[b]These parameters were used in a 40 by 40 matrix to generate ten years of multivariate, random corn and soybean prices and yields.

that results in either low or high returns will influence land prices. A crucial component of this research is an Almon lag land price model. Hauschew and Herr have demonstrated that such a model performed well in explaining U.S. farm land prices. The following model was developed using 1959-1979 Illinois data:

$$V_t = \underset{(3.39)}{-23.8} - \underset{(79.12)}{210.06}FLB_{t-1} + \underset{(.119)}{.723}CPI_t + \underset{(.012)}{.0068}R_t$$

$$+ \underset{(.0094)}{.069}R_{t-1} + \underset{(.0092)}{.105}R_{t-2} + \underset{(.0091)}{.117}R_{t-3}$$

$$+ \underset{(.0078)}{.103}R_{t-4} + \underset{(.0048)}{.064}R_{t-5}$$

where

V_t = the index of Illinois farm land values (1979 = 100);

FLB_{t-1} = the annual Federal Bank interest rate, lagged one year;

CPI_t = the consumer price index (1979 = 100); and

R's = the budgeted returns from previous years with coefficients that follow a second degree polynominal (Standard errors are reported in parenthesis).

The R^2 is .997 and the Durbin-Watson statistic suggest no autocorrelation. All signs were as hypothesized and lag structure followed the expected pattern. This model was programmed into the Monte Carlo simulator. Since land prices are determined with internally updated random budgeted returns the land price represents a regional price (i.e., central and northern Illinois) for land with 85-100 soil rating.

Data for the Almon lag model were compiled from the Illinois budget data, *Annual Summaries of Illinois Farm Business Records*, and a paper by Scott. A budgeted return-to-land costs was calculated for years 1959-1979 using the actual prices and yields and the nonland cost estimates. Percent of acres planted to corn versus soybeans was based on trends over the period (65 percent corn in 1959-1965, 60 percent corn in 1966-1969, and 55 percent corn in 1970-1979). These percentages were coupled with the historical data to develop the data set on budgeted return per acre. These data were used to fit the Almon lag model.

The Experimental Design

Controlled environments were developed in order to compare results that used the Almon lag model (and provided for land and returns interactions) and those that used a fixed price of land over the planning period. A general equilibrium, inflation-free environment was created with the following relationships: (a) returns to land of 3.5 percent, (b) fixed interest rate of three percent, (c) intermediate interest rate of 3.5 percent, and (d) short term interest rate of four percent. Fixed and intermediate debt is retired on an amortized schedule with any negative cash flows covered by short-term debt.

The only investment over the time period is for machinery and building replacement. Thus, operating sizes are fixed over the time horizon. Four sizes of farms (300, 600, 900, and 1,200 acres) with full land ownership are simulated for each experiment.

A Monte Carlo simulation provides the opportunity to develop both expected values and measures of variability. Therefore, this method provides a means of studying farm survival under various conditions. Although no satisfactory measures of survival exist, a common method is to examine the debt-to-asset ratio. In this study, any debt-to-asset ratio that exceeds .8 *in the final year* causes the farm to become insolvent, i.e. it fails.

The simulation experiments are designed so that each farm begins with the same debt-to-asset. Clearly, the choice of beginning debt-to-asset ratio is subjective. For this set of experiments a level very close to the .8 level—.78—was chosen. The Illinois farm environment is less risky than most, and choosing a beginning debt-to-asset ratio much lower than .78 would not result in many farm failures. This is particularly true since farms only begin with .78 debt-to-asset; they have the opportunity to lower this as they retire debt over the time period.

Another financial statistic is generated wealth. This value reflects the change in net worth plus the stream of family living withdrawals. The calculation is

$$GW = (NW_{t=10} - NW_{t=0}) + \sum_{t=1}^{10} C(1+r)^t$$

where

GW = generated wealth over the time period;

NW = market value net worth;

C = consumption expenditures;

r = the risk-free interest rate (set equal to the fixed rate); and

t = the number of years from the beginning of the simulation period.

Results

Results clearly indicate that incorporation of the interaction between the land markets and returns affect risk. When the land market is related to returns, the odds that the debt-to-asset ratio will be above .8 are 50, 19, 11, and 8 percent for the 300-, 600-, 900-, and 1,200-acre farm, respectively. Without land market interactions, only the 300-acre farm exceeds this constraint (42 percent). The properties of ending debt-to-asset ratios are reported in table 2. Although the mean differences in ending debt-to-asset ratios are different when comparing results with and without land market interactions, they are not significantly different. However, relative measures of risk, such as standard deviation or coefficient of variation, are more telling. The most striking comparison is between the coefficient of variation with and without land market interaction. These values suggest that the relative risk (when examining debt-to-asset ratios) increases by roughly 2.5 times for all farms when land market interactions are considered.

Examination of generated wealth values suggests that relative risks are even greater when land market interactions are modeled. In

Table 2. Simulation Results That Account for Land Market Interactions Compared to Those That Do Not[a]

Farm Size	300 ac	600 ac	900 ac	1200 ac
With Land Market Interactions				
Ending Debt-to-Asset				
Mean	.801	.716	.692	.681
Std deviation	.100	.092	.089	.087
Coef of variation	.1250	.1288	.1285	.1277
Generated Wealth (in $1,000)				
Mean	197	387	547	696
Std deviation	135	258	376	493
Coef of variation	.685	.667	.687	.708
Without Land Market Interactions				
Ending Debt-to-Asset				
Mean	.790	.705	.681	.671
Std deviation	.039	.038	.036	.035
Coef of variation	.0491	.0540	.0533	.0519
Generated Wealth (in $1,000)				
Mean	200	394	558	710
Std deviation	53	92	124	154
Coef of variation	.265	.234	.222	.211

[a]Statistics were developed from 100 simulations. (i.e., 100 ten-year periods were developed with random price yields.)

addition, relative risk increases as farm size increases. The coefficient of variation is 2.6, 2.9, 3.1, and 3.3 times greater for the 300-, 600-, 900-, and 1,200-acre farm respectively. Therefore, studies that ignore land market interactions not only underestimate risk but may also misrepresent the relative risk of different size farms.

Conclusions

This research demonstrates the importance of developing appropriate relationships between income risk and asset risk when modeling farm survival. If these interactions are ignored, the research will underestimate risk and may lead to inaccurate conclusions regarding the relative risks that are inherent in different size farms. Further research is needed to investigate these relative risks. Since lenders continue to base their decisions on both asset values and cash flows, it is essential that farm survival research properly account for the relationships between income and asset values. The approach presented here offers one such alternative.

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